Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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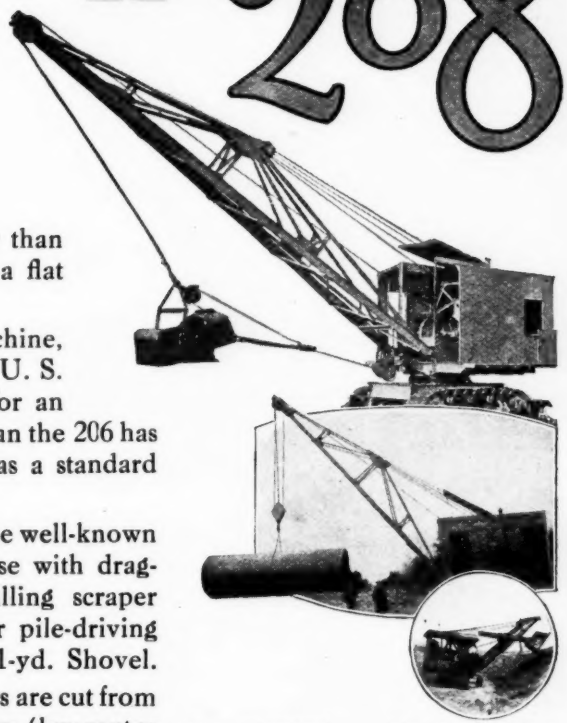

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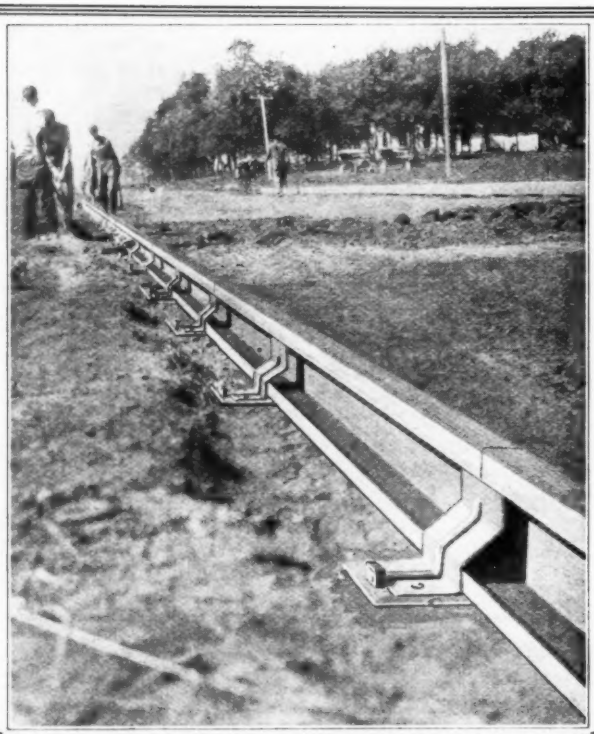

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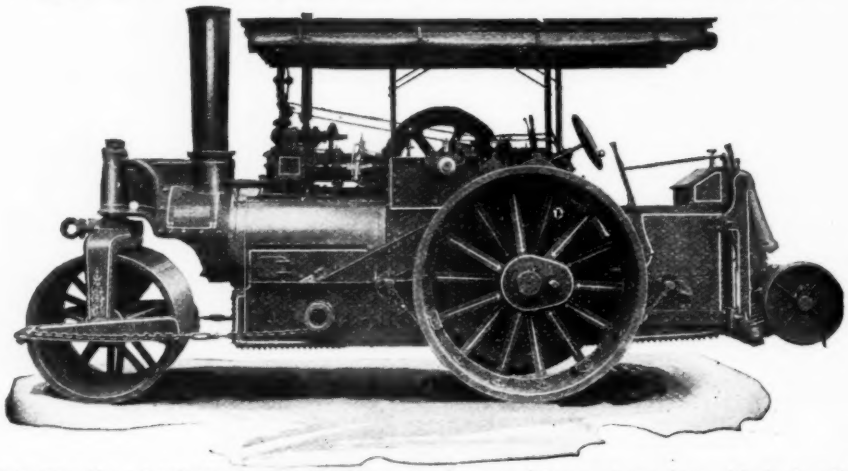

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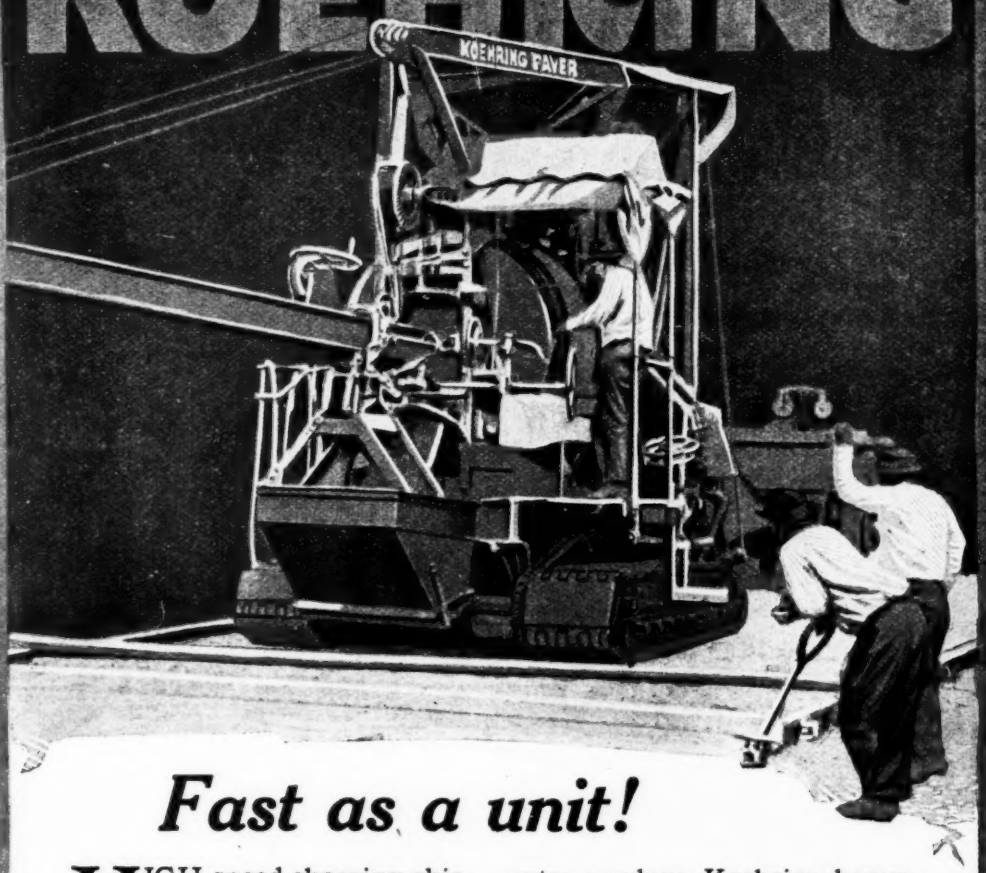

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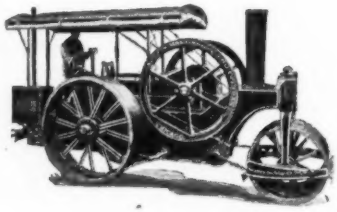

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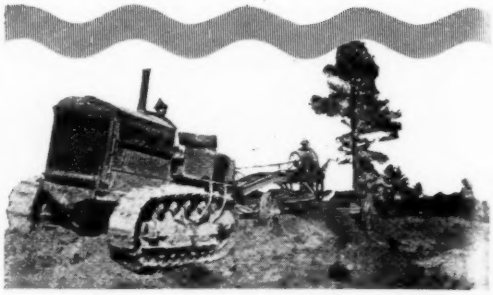

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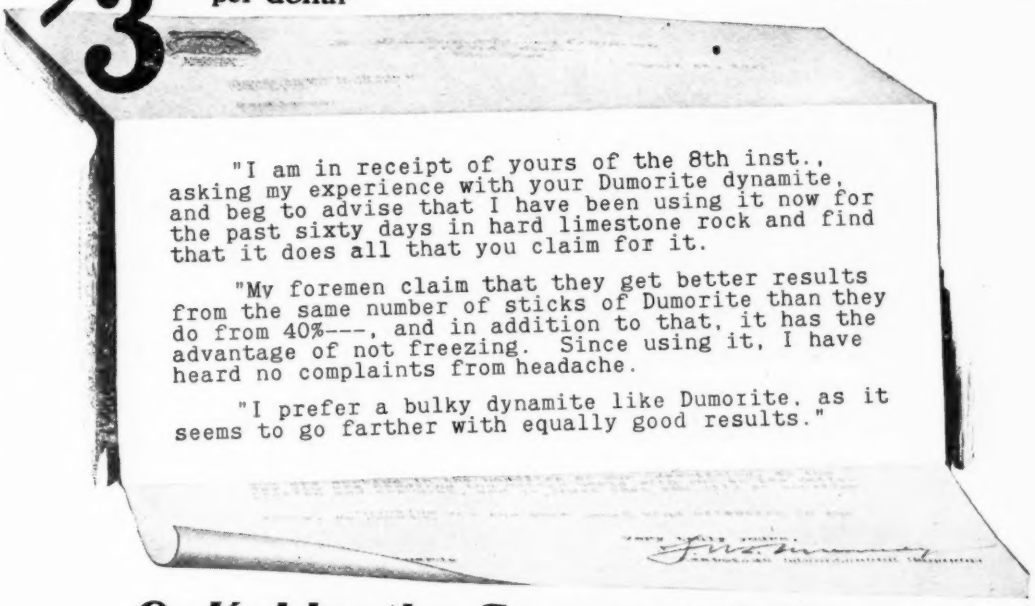
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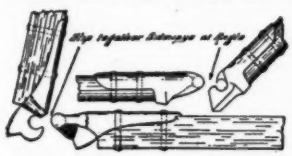

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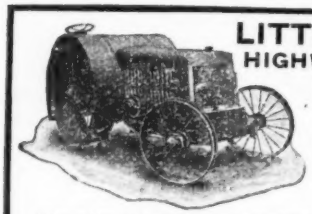

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Motor Truck Operation and Accounting—85

MOVING A VILLAGE ELEVEN MILES BY TRUCK AND TRAILER

By W. A. Carpenter, Acme Motor Truck Co., Cadillac, Mich.

The developments of the past ten years in the automotive industry are almost startling, when one calmly reviews them. Tasks that a few years ago would have been called impossible and wild dreams, have been successfully accomplished by the truck and trailer. Practically everything movable has been moved, and almost daily we hear of some new triumph of automotive engineering. This is the story of one such accomplishment.

The Acme Motor Truck Company, of Cadillac, Mich., has just built a trailer of unusual design, that is being used in a unique and unusual job—moving practically an entire village a distance of 11 miles.

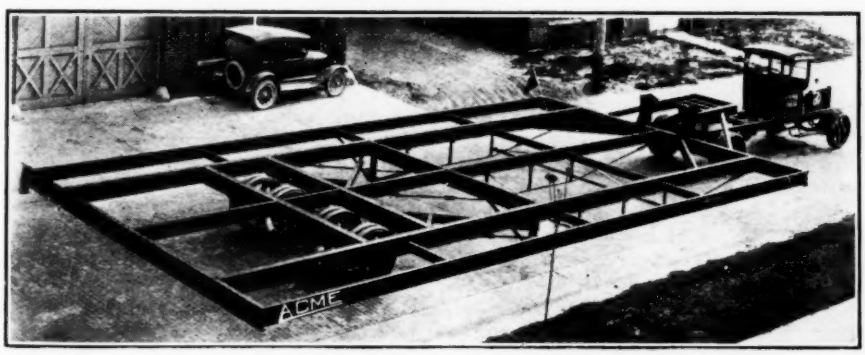
The town of Jennings, 11 miles north and east of Cadillac, was founded about a quarter of a century ago by the Mitchell Bros. Lumber Co. A saw mill, chemical and flooring plant gave employment to approximately 500 men. Jennings was a "company town," for, though it had a number of churches, "opera house," roller skating rink, community house, band stand, jail and other civic buildings, there was but one store in the village, that a general one, carrying all sorts of supplies, really a department store. About every able-bodied man in the village was employed in one of the three company mills.

When the village was founded the unbroken hardwood forests surrounded the village for miles and miles in every direction. A beautiful little lake nestled among the hills, the waters of which were alive with gamey bass, pike, perch of unusual size and many other varieties of fish. Life in the little village was very nearly ideal. The company paid good wages and the needs of the inhabitants were simple.

But as the years rolled around, the standing timber around the village gradually disappeared before the onslaught of the men with axes and saws, until a few months ago the last of the big trees fell, and then it was only a question of time when the fires in the boilers would be drawn and silence fall over the mills.

Various plans were considered for the preservation of the industrial life of the happy and contented little village, but all were discarded. Then was born the idea of moving the mills, the families and the residences to Cadillac, 11 miles southwest. Many plans were considered and rejected as impractical before the motor truck and trailer was considered. Acme engineers studied the problem from every angle, then finally W. A. Kysor, president of the Acme Motor Truck Company, submitted a report to the lumber company which was accepted, and the gigantic trailer illustrated in connection with this article was built.

The next thing to be considered was the road over which the 30 to 45-ton load would have to pass. About 8 miles of the distance is over the Michigan Trunk Line M55; the rest of the way over a fairly



VIEW OF TRUCK AND TRAILER DESIGNED AND BUILT BY THE ACME MOTOR TRUCK CO. OF CADILLAC, MICH., FOR MOVING THE VILLAGE OF JENNINGS TO CADILLAC, A DISTANCE OF 11 MILES.

good dirt road. Considerable work had to be done on this highway, the roadbed widened at a number of points, and in all cases of this kind heavy planks or timbers were laid smoothly to make a level roadway. A bridge across the Clam River was widened and reinforced. In the village entire streets were paved with heavy green planks to sustain the weight of the load, as the soil there is largely loose, soft sand.

The houses to be moved vary in size from 24x30 ft. to 24x40 ft. Many of them have hardwood floors, all are a story and a half high, well-built, comfortable and arranged for convenience. The weight of the houses varies from 15 to 35 tons. The windows are left in all of them. So perfectly does the trailer function that there

RESIDENCE OF THE JENNINGS VILLAGE MARSHAL EN ROUTE FROM JENNINGS TO CADILLAC. SIZE OF HOUSE 24x40 FT.; WEIGHT ABOUT 35 TONS.

is not the slightest jar in any part of the journey and not a window has been cracked, except in passing through the City of Cadillac, when the limbs of shade trees along the street broke one or two when the first house was brought in.

The 11-mile trip is made in about 4 hours, which includes all necessary stops to wait for traffic to pass before entering upon a stretch of road too narrow to allow passing, though the actual running speed is from 5 to 8 miles per hour. Loading and unloading and passing through the city requires a longer time than that, as it is often necessary to remove the electric light and telephone wires to allow the house to pass under.

At the time this article is being written the rate of moving is about two houses every three days or four per week, although as the crew doing the work grows more accustomed to it, it is thought a house a day will be brought over. There are from 75 to 100 of these residences to be moved, so the work will require all of the rest of the year, although there is a possibility that an early and heavy fall of snow may retard the work and make it necessary to complete the project in the spring of 1923.

The flooring and chemical plant will also be brought to Cadillac, which will result in an increase in population of that city and make additional homes necessary, there being at the present time a shortage of houses in the city.

Many of these houses are being sold at a very reasonable price to workingmen, making it possible for a man receiving average wages to own a very comfortable home, with all modern conveniences, for considerably less than $2,000.

So Cadillac gains two important industries, from 75 to 100 new houses and from 500 to 1,000 added population, at the same time.

The Trailer

A technical description of the trailer follows:

The trailer is constructed with a framework of heavy structural steel beams. A channel and I-beam platform, raised 18 ins. above the trailer frame and rigidly connected to it, transfers the load at the forward end of the trailer to a rocking fifth wheel mounted on the truck. This construction eliminates all twisting stresses from the trailer proper.

The trailer frame is supported at the rear by four steel truck wheels abreast, equipped with solid rubber tires. These wheels are placed under the trailer in such a position that approximately 75 per cent of the weight of the trailer and load is carried on them, thus making it possible to carry a very heavy load on the trailer without overloading the truck used for motive power.

The trailer is designed to carry safely a maximum uniformly distributed load of 35 tons, and the complete unit weighs approximately 5 tons.

Frame.—The trailer proper is 24 ft. wide by 42 ft. long. It consists of five longitudinal members of heavy section structural steel, securely held in place by two main and four supplementary transverse beams. Diagonal cross-braces are built into the frame to distribute the stresses where excessive weaving and twisting would occur. To give added rigidity and strength to the structure the three center longitudinal members are reinforced with large truss rods securely anchored to the member at each end and supported at equal intervals by cast-iron struts. The tension in these rods is equal-

ized by a series of turnbuckles. All frame connections, gussets, braces, etc., are hot-riveted, the entire frame reflecting the skill of the structural workers.

Front Support.—The platform at the forward end of the frame is raised 18 ins. above the trailer. It is constructed of channels, I-beams and plates, and substantially braced with diagonal members to the forward transverse member of the trailer proper in order to eliminate side sway. This platform is connected to the trailer frame by means of heavy gusset plates and channels of sufficient strength to transfer safely approximately 25 per cent of the weight of the trailer and load to the rocking fifth wheel mounted on the truck.

Running Gear.—At the rear the trailer is carried on four cast-steel truck wheels, all abreast, equipped with 40x6-in. dual truck tires. The wheels are arranged in pairs, each wheel operating on tapered roller bearings supported by a tubular steel axle shaft. The shafts of each pair of wheels are bolted together at the center through a large steel casting, which is supported by an extra heavy wrought-iron pipe extending through it and at right

MOVING A HOUSE 11 MILES BY ACME TRUCK AND TRAILER.

angles to the shaft. Heavy steel pillow blocks at either end of this pipe support the weight of the trailer and load through coil springs attached to the trailer frame. This unique construction not only cushions the load, but successfully provides for road inequalities, which is very essential when taking into consideration that the distance between the outside wheels is approximately 11 ft.

To relieve the springs from driving stresses a radius rod with flexible connections is provided for both sets of wheels, the forward end of which is secured rigidly to the trailer frame and the rear end fastened to the end of the wrought-iron pipe through a swivel connection.

In order to maintain perfect alignment of all four wheels, the wrought-iron pipes supporting the axle shafts are tied together by a system of flat bars secured to the trailer frame and so arranged as to compensate for spring deflection.

The distance from the top of the trailer frame to the ground is approximately 40 ins. when the trailer is loaded.

Method of Loading.—The house is raised by a series of jacks located at each side. The two outside longitudinal members of the trailer, which are bolted on, are removed. The trailer is then backed under the building and the house is lowered until it rests evenly on the trailer frame. The side members are replaced if it is found necessary, and the unit is ready for its journey.

Motive Power.—Acme Truck Model 125 Chassis is furnished with this trailer. It is equipped with a Continental Motor which develops 55 H. P. actual brake test. This power, together with a gear reduction of approximately 71 in first speed, delivers a tremendous torque at the rear wheels, which is proven by the fact that we were able to negotiate a 6 per cent grade 600 ft. long over gravel road with a 35-ton load on the trailer.

RECENT DEVELOPMENTS IN MOTOR BUS TRANSPORTATION

By G. A. Kissel, President Kissel Motor Car Co., Hartford, Wis.

After an investigation of the inter-city motor bus lines operating in different sections of the country and a comparison of the results with those factors that created the necessity for this means of transportation, such as inadequate railway facilities and railroad equipment, one can not help being impressed with the fact that the motor bus as a passenger transportation unit has hardly touched the surface in the field of inter-city passenger transportation.

I understand that most leading centers have outgrown or are outgrowing local transportation facilities. The automobile has made this up to a great extent but the automobile is limited as to passenger capacity, while in most cases a conveyance or vehicle designed to carry a number of passengers on a prescribed route or schedule is what is needed.

Not only is this lack of transportation

felt severely between centers but even between states, and it would seem that these needs must be filled by other carriers than a street railway and railroad, because these requirements have been in existence for several years and as yet no concerted action has been taken by the public carriers to eliminate it. Thus was created the necessity for a motor transportation unit that could step right into place and begin operating without waiting for the construction of a right of way, or confining its operation to a prescribed route.

A survey throughout the country will show that practically every metropolis as well as cities and small towns are connected by motor bus routes and each year has seen an increased patronage by the public. Indeed, this increase has been so consistent that many motor bus companies have built up properties in the way of service stations, passenger depots, waiting rooms, etc., that are the equal of many railroads.

This public acceptance, which was remarkable at the very start of the motor bus entrance as a public utility, is indicative of the business that can be built up if the units are comfortable, attractive, safe and speedy.

We all can remember the first busses that were built—with a truck chassis and motor and a body built high up. decidedly awkward in appearance, uncomfortable for passengers and uncontrollable for the driver.

With true American ingenuity and inventiveness, motor bus makers have lately been showing rapid improvement, both in mechanical engineering and in body design and equipment. Today in some sections of the country, the busses are just as comfortable and attractive and up-to-date as are railroad parlor cars. Especially is this true in those scenic sections where railroad facilities are not as plentiful as they are in other sections and where overland transportation must be depended upon to a great extent.

Manufacturers and their engineers have solved the motor bus problem by building the body low over the chassis and giving them sufficient live weight with proper weight and balance that absorb the irregularities of the road, and by padding and upholstering the seats have been made very comfortable and not hard at all to enjoy even on long distance journeys. Without going into detail concerning busses of this character, I have often wondered whether it was really necessary to design and build such a heavy vehicle in order to attain maximum riding comfort and roadability.

The result of all our investigations along these lines, we boiled down to the essential factors around which we built the new Kissel Coach Limited for urban use, and which are as follows: 1, parlor car comfort; 2, perfect roadability; 3, the safety feature; 4, ease of traffic control; 5, proper speed; 6, operation and maintenance economy.

Every one of these items is found in the automobile of today, especially in the limousine or sedan type and we held that if we could build a sedan along the lines of the Kissel coach sedan, but accomodating 18 passengers, we would produce the ultimate in motor bus design and development. We felt that we would be giving the public touring pleasure with sedan comfort, and that the public would be quick to appreciate the advantages of such de luxe accomodations and would be perfectly willing to pay the increased cost.

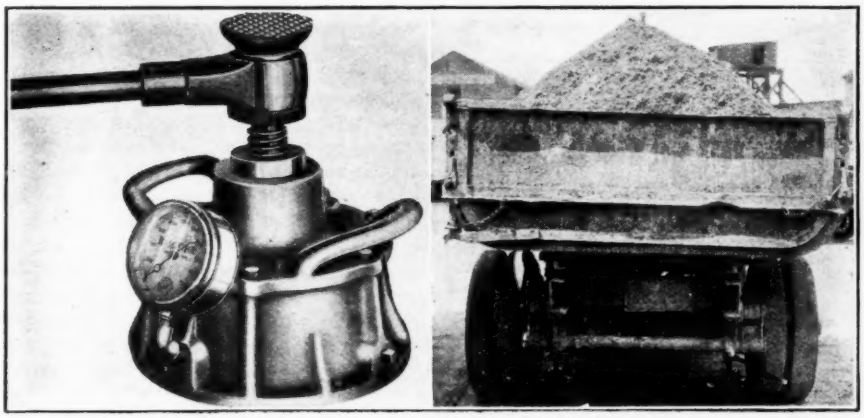
Investigation among leading bus owners brought forth the fact that the public was perfectly willing to pay for de luxe travel on runs over 25 miles. In that case we believe motor bus operating companies as a whole will find it profitable to add to their present fleet a sufficient number of de luxe units to operate on a regular urban schedule but at a higher cost to the public. In other words, they would be offering the public parlor car accomodations. While the bulk of the traveling public prefers the day coach, there is a big proportion of the public that is willing to pay a slight increase in cost to secure the ease and relaxation as well as pleasure and satisfaction of the parlor car. It is also estimated that the use of such a class of vehicles as the Kissel coach limited would quickly create a desire on the part of the public for first-class motor bus accomodations which in itself will do a great deal to make the motor bus not only a recognized means of public transportation, but also what is still more important, a permanent public utility.

HOW HIGHWAY OFFICIALS CAN CHECK UP TRUCK LOADS

It has been a problem with state and county highway officials for the past few years to devise a scheme to determine whether or not their truck overloading laws were being complied with. They did not know just how to go about checking up overloaded trucks in an efficient man-

ner. In some states standard platform scales were installed on main highways, and for a while they seemed to solve the matter, but soon truck operators who intentionally overloaded their trucks would locate these scales and would detour them. It was soon obvious that some other method was necessary for determining truck loads on the highways.

A few years ago a portable weighing device was brought out in the form of a loadometer. The loadometer resembles a jack with a cylinder filled with oil, which supports a piston, on which the load is applied. There is a high pressure gauge connected with the oil chamber, on which the load is registered. The instruments can be conveniently transported from one place to another, as they weigh only approximately 40 lbs. each. A number of highway officials, who were trying to find a means of telling whether their overloading laws were being complied with, soon saw that these portable weighing devices were just what they had been looking for.



VIEWS OF THE LOADOMETER FOR WEIGHING MOTOR TRUCKS AS A MEANS OF PREVENTING OVERLOADING.

Several states started out to check up the loads traveling over their highways, and in the state of Maryland 150 trucks were found overloaded during the first week of the campaign. This was a big benefit to the truck operators, as in a number of cases they were ignorant of the fact their trucks were loaded beyond capacity, and were unconsciously abusing them. It has been quoted by a large truck operator on the Pacific coast that 20 per cent is taken off the life of trucks and tires that are constantly loaded beyond their capacity. He further stated that any employe of his was discharged on the spot who either overloaded his truck or drove at a speed exceeding 15 miles an hour. There is also danger of brakes not being able to hold when an overloaded truck is coming down a steep grade and the life of other people on the road is jeopardized.

The portable weighing device can be used on any highway and at any point on such highway, and truck operators who intentionally overload do not know when and where to detour to avoid the loadometers. The highway officials, with the use of these instruments, are educating the public to load their trucks within reason, which makes the highways better and safer for all who use them.

NEW YORK CITY BUYS 128 MORE WHITE TRUCKS

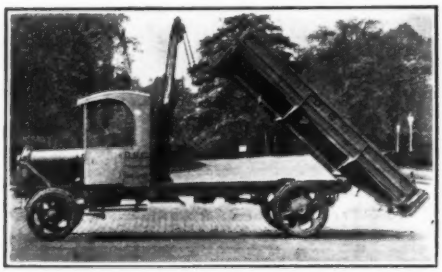
A contract for 128 5-ton motor trucks, just awarded by the City of New York to The White Company, Cleveland, following a previous order for 212 trucks of this make some time ago, gives The White Company the two largest orders for motor trucks ever placed by a municipality and gives the street cleaning department of the City of New York the largest known fleet of standardized heavy duty trucks.

Specifications required bidders to produce verified records showing at least 100 heavy duty trucks which have covered more than 75,000 miles. This requirement was a simple one for The White Company, which qualified in this respect two years ago.

One hundred and twenty of the trucks will be equipped with power dumping bodies developed especially for refuse collection under the conditions existing in New York. Each will carry 6 cu. yds. of refuse. They will be used for all phases

of street cleaning work, including the removal of ashes, garbage and snow. Six will be provided with winches and two will be equipped with apparatus for handling wrecks.

New York City has found motor trucks essential in keeping its thousands of miles of streets in a sanitary condition. The city has a nation-wide reputation for clean streets, and because of the constant growth of the street cleaning problem, large investments in motor equipment



TYPE OF WHITE HEAVY DUTY TRUCK PURCHASED BY NEW YORK CITY FOR STREET CLEANING WORK.

have been necessary. To protect the city against the blocking of thoroughfares by heavy snowfalls, such as happened two years ago, when New York traffic was paralyzed for days, a method of attaching snow plows to the front of the trucks was developed, and, on short notice, the city can throw into service a great battery of snow fighters.

THE HIGHWAY AS A LIVING FORCE

By Pyke Johnson, Secretary Highway Committee, National Automobile Chamber of Commerce, 366 Madison Ave., New York, N. Y.

If there is any one fact which should be impressed upon the people of America today it is that we can no longer think of the highway merely as a material thing. The highway is a living force which serves to bind the people of this country more closely together, which stamps out isolation and heightens our standards of living. Into its building and use go all of the elements of romance and adventure which the railroads had in the olden days, and it is only as we emphasize anew these phases of the highway question that we can hope first to instil an esprit de corps in the men who are carrying on the work today and second to appeal to the youth which will cause him to turn to the work tomorrow.

How many men are there today who can look back to the time when, as boys, they sat on the old rail fence watching the trains go by and pictured themselves as the ones who would handle the throttle of the engine in the future? How many men are there today who have read far into the night with bated breath the stories of those days of adventure when the pioneer gangs of the railroads broke their way through the wilderness for the steel rails to follow, and how many men are there today who realize that in highway transport they have at their very threshold the same opportunities for romance and adventure, the same opportunities for civic betterment that the railroads carried with them in the old days?

How many men know that today the road highway gangs of the states and government are traveling on snowshoes in the northern country, surveying the way for the highways to come; that other gangs are hanging suspended from high cliffs over rushing waters that the highway may be broken along the canyon's side; that throughout the Western country men are forcing their way through virgin forest in order that means of communication may be opened up? How many men know that in the use of highways China is finding a means of prevention of famine? Brazil is opening up a vast new empire of hard woods and produce, while in our own country on every side the building of new highways is infusing new life into communities deadened by loss of trade transferred to other communities more fortunately situated through forms of transportation.

In our own country transportation has always been a decided factor in our advancement. Those who recall the story of the first settlement of the United States know that postal development came first because of the need for retaining communication with the mother country. Inland waterways were the first channels of communication with the interior and these were followed by the beginnings of a national highway system in the early construction of the National Pike. The advent of the railroad checked this development and for a period of more than a hundred years we find that the economic zones of commerce in this country have depended largely upon the railroads which, generally speaking, pushed from the east to west and from north to south.

In all of the thousands of years of

development of transportation there was no real progress in highway transport until the advent of the motor vehicle 27 years ago. Until that time the transportation vehicles of the ancients were practically as efficient as those of the modern farmer. Searchers in archaeological records of the past discovered in a tomb 4,000 years old a wheel with a demountable rim, and aside from a few refinements in the wagon and a better breed of stock no real advancement was made in all this period. Then came the motor vehicle. Twenty-seven years ago there were four of them in the United States. Today there are more than ten million cars in the United States, or one to every ten persons or to every two and a half families. In many cities the average is so low that the entire population of a community could be transported at one time in motor vehicles. What the future may hold for further development no one can say, beyond making this one statement, that every normal man and woman is a potential prospect for the automobile salesman because of that inherent desire for individual transportation which first finds its expression in the youth sitting on the rail fence watching the trains go by.

However, there are those who prefer to consider these questions from a standpoint of their effect on economics, and for this class I would suggest that what we are dealing with here is a fifty billion dollar industry—transportation.

What is the future of this great industry? What are the problems which it brings with it, what is the field of opportunity which it affords to the youth of the country? Twenty-five years ago the major problems of transportation seemed to be solved. The imposition of a vast, heavy mode of traffic on our highways, with its enormous development and its immense requirements of all kinds of raw material, its acceleration of all other forms of industry have changed all this. New and intricate questions are present from all sides and it is perhaps enough for the purpose of this discussion to indicate only a few of the more important.

The first question to be answered is whether or not there is need for a highway in any given location. Does the economic welfare or the imponderable benefit to be derived by the community require its construction? What do the surveys and traffic data show? What changes should be made in the highway itself? What saving can be effected in the traffic over the highway through new gradients, banked curves and other refinements of modern highway construction to reduce tractive and power resistance? What means shall be found for the financing of this undertaking, larger than any other domestic activity of the government?

Political boundaries are no barrier to the cruising radius of a motor vehicle. A local community can not be expected to bear the full expense of maintenance of rights of way for travel which might originate and end entirely without its jurisdiction. From the standpoint of the general public, is it well to thrust a burden of taxation upon a unit of transportation which in one of its aspects alone, that of the excise tax imposed by the federal government, reaches a total today greater than all the tax paid by all of the corporations in the United States prior to 1916. How far is its economics to go in the imposition of motor registration fees, $108,000,000 of which were collected for the first six months of last year, according to the figures of the Bureau of Public Roads, or, putting it another way, $6,000,000 more than was collected throughout the entire year of 1920, always remembering, however, that collections are far greater in the first half than in the last six months of the year.

What is to be done regarding the administrative control of the highway, both in construction and maintenance, as well as operation? Can this question be left long a local unit when it is indicated the use extends beyond local bounds? It would appear that systems of highways will be necessary. How are these systems to be finally selected and classified?

Another question which must be answered is that of the responsibility of locating and financing our main highways. It is obvious that where traffic is generated in one county, runs through another and has its terminus in a third county, the second county does not receive much benefit, but its roads are used.

The same statement is true with reference to states, particularly in the east where much of the traffic across Connecticut and New Jersey, as outstanding examples, comes from other states. Quite obviously it is unfair to expect the county or state so used to bear the largest part of the burden and we should have overhead funds which could be devoted to the improvement of particular stretches of highways which serve more than local needs. In these cases it would seem that

the funds should come from a state source and should be expended under the state direction.

The task of taking care of the local highways is a large one and assistance of this kind would come as a welcome relief to county officials already overburdened with demands of more miles of roads than they can build within a reasonable length of time.

The whole question of our road program is a question of education, money and time. If we hope to see the road program completed in ten years, we should be ready to expend at least $100,000,000 from our national treasury and to maintain the present state and county programs at their present levels.

If we want to wait 15 years for the job, we must cut the federal figures to $75,000,000; if we want to wait 20 years, we can cut the amount to $50,000,000. But if we do wait we will pay a heavy penalty in excess of transportation costs and many of us will not live to see the job done.

The question of traffic control has become a major one in many cities. It extends also to the rural use of the highway. It involves even the very physical contours of metropolitan development and always it carries with it major questions of safety which must be solved.

Then we have again that other question of the interrelationship of transportation. What new form of development are we coming to in intrastate traffic? Is the terminal to be continued? It appears that the modern development of the motor truck is to supplement the rail lines, to take from it those short hauls which have been unprofitable, or perhaps for the railroad itself, and this seems a more logical conclusion, to use both forms of carrier. What is the field for this development? Where do the highway transport vehicles stand in relation to the waterways and the electric lines? All have their economic place. The question is its development.

So the inquiry might be carried on—questions of construction, of maintenance, of operation, of financing operation—all these point heavily to the none too plentiful resources in trained men available today.

Thousands of men will be needed in the future in all phases of this great problem of highway transport. The field is a vast one limited only by the range of human communities. It transcends the question of development of this country. It penetrates into every section of the globe. In it is afforded a place for the young man and a place which calls for service of the highest type, and it will not be until we have arrived at a thorough understanding of these questions of the development of highway transport that we can hope to reach the ideal of a quickened America which only the highest type of transportation facilities can afford.

THE FIELD FOR LIGHT, FAST TRUCKS

Before deciding to enter the light delivery truck field with the new Fast Express, the Federal Motor Truck Company conducted an exhaustive investigation into the country's requirements for lighter capacity trucks.

This investigation revealed that 65 per cent of all trucks in use are of 1-ton capacity or under. In many businesses, a considerably larger proportion are of this popular size. For instance, over 80 per cent of the trucks used on farms are of this size.

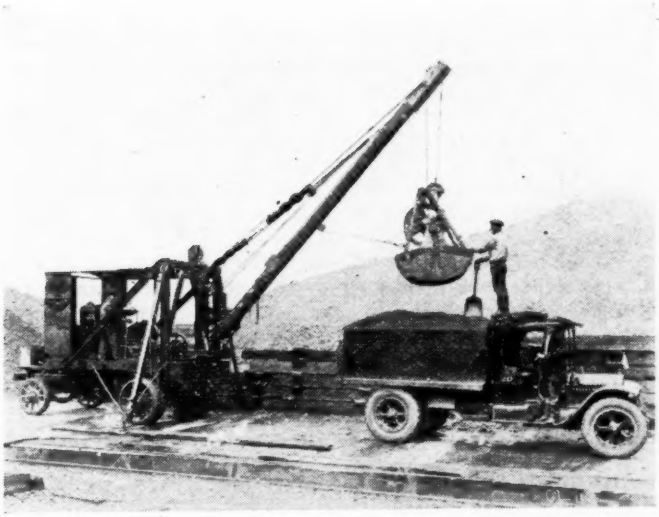
The Federal investigation also revealed that there is a constantly increasing demand for lighter and speedier trucks. The biggest demand at present comes from farmers. There are 6,448,343 farms in the United States. Of this total 2,673,331 are farms of 100 acres or more. Ultimately there will be required at least one light truck for each two farms of 100 acres or over.

There are hundreds of thousands of smaller farms given over to fruit growing, truck gardening, poultry raising and the like, on which the high value and perishable nature of the crop produced per acre make motor transportation to market most economical and necessary. In view of these statistics, the Federal company believes it is more than conservative in estimating that at least one truck will be required for each four farms in the United States, or a total of $1,500,000 trucks.

MOTOR TRUCK MOUNTING FOR BYERS CRANE

A big forward step in "taking the crane to the job" has been made by The Byers Machine Company, of Ravenna, Ohio, in bringing out a crane that can be mounted permanently on a motor truck.

The new outfit, called the "Byers Truckrane," can be driven from the garage to



THE BYERS "TRUCKRANE," A MODIFICATION OF THE AUTO-CRANE ADAPTED FOR MOUNTING ON A MOTOR TRUCK.

the job every morning just like any automobile, or driven from one job to another with a minimum of time lost in travel.

In addition, its increased "movability," together with the strength and comparative lightness of the unit, open a new field of crane service. Owners whose work has hitherto been too limited to operate a large crane, can, it is believed, use a machine of the "Truckrane" type at a profit. It should prove an ideal piece of equipment for general contractors, material and supply dealers, counties, municipalities and industrial plants.

The crane, unmounted, weighs only 6 tons, and is similar to the Byers Auto-Crane Model "1" in every respect, except that it has no wheels, jackshaft nor differential and drive chains. It has a power drum for raising and lowering the boom, which is of steel.

The crane is furnished with a Hercules 4-cylinder 4x5-in. engine, developing over 30 H.P., to be operated with gasoline power. Any half cubic yard bucket weighing not over 2,000 lbs. can be used with it.

It is not at all necessary to use a new

ANOTHER VIEW OF THE "TRUCKRANE."

truck for the mounting. One that has seen 90 per cent of its usefulness, having a motor that is capable of turning over, is all that is needed. Bargains in half-worn-out motor trucks can be had everywhere, making the first cost of a complete outfit extremely reasonable.

The "Truckrane" shown above is owned and operated by The Worth Motor Service Company of Chicago.

The Byers Company has already started the erection of additional buildings and machinery required to manufacture the "Truckrane" on a large production basis without any interference with their standard lines of "Auto-Cranes," revolving cranes and hoists.

EQUIPMENT DIVISION OF NEBRASKA DEPARTMENT OF PUBLIC WORKS

The Equipment Division of the Nebraska State Department of Public Works occupies eleven acres of land in the city of Lincoln where machinery and equipment is stored and repaired and sold and rented to contractors and counties all over the State. Two large, commodious buildings have been erected on this tract, a warehouse 250 ft. wide by 500 ft. long and a repair shop 150 ft. wide by 285 ft. long. These comprise the only buildings and are not sufficient to store all the equipment as many of the trucks and tractors are kept outside in the yards. The matter of storage is not serious, however, because this stock is being continually changed by disposition and replacement. Procedure of the Equipment Division is described as follows in a recent issue of the Monthly Report of the Department:

The Government trucks are of the 2-wheel-drive type and of well-known standard makes such as Federal, Packard, Garford and Liberty. The market value of these trucks ranges from $3,500 to $4,500, but are transferred to the counties for road work for $1,000 to $1,500. Of course most of these trucks are not new, but many are practically so, and others will render much good and substantial service. The best trucks are being rapidly picked over. The State reserves the right to refund the money and call in a truck at any time. This is done when the trucks are being used for other purposes than provided, and not for legitimate road work. Not only are trucks let out, but they are also rented to the counties or to contractors on State work for $9 per day. This often allows the county the use of the truck without so large an expenditure of money.

The Holt 10-ton "Caterpillar" tractor is leased for $3,500 and rents for $25 per day. The 20-ton tractor leases for $2,600 and also rents for $25 per day. The trucks are used for light maintenance and graveling and the tractors are used for heavy construction work. Practically all the trucks purchased by the counties are secured from the Equipment Division. Heavy grade Veedol cylinder oil is sold for 75c per gal. in 55-gal. lots. Other equipment sold for road gangs include:

Elevator Graders	$750.00
High Speed Trailers	$250.00
Bunk Houses mounted) 9½x20	$250.00
Bunk Houses (in sections)	$ 35.00

About 40 of the mounted bunk houses have been disposed of in the last three years. The bunk houses are rented to engineers and contractors for $1.00 per day. To help furnish these outfits, the Division sells the following:

Tarpaulin	5c and 6c per foot
Mattresses	$4.50 to $6.00 each
Blankets	$1.50 to $6.00 each
Pillows	$1.50 each

An unlimited supply of equipment is on hand for the use of the engineer in the field such as transits, rods, chains, tape, etc. These are checked out to the engineers when they leave for their projects. Dodge and Ford cars are rented to them at 12 cts. per mile exclusive of repairs. Dynamite for blasting is on hand at 25 cts. per pound in small quantities. In larger quantities, reductions are made. Caps for the dynamite sell for 2 cts. each and fuses at 2 cts. per ft. This concentration of field equipment in large quantities in one place not only lessens expense but saves time in the transmission of supplies to the engineer.

Repairs for all equipment sent out are made at the repair shop and the counties are billed for it. All is done at minimum expense; 36x6 in. solid tires for trucks are pressed on for $20. A machine for acetylene welding has been installed. The recording of repair parts on hand is facilitated by the use of a perpetual card invoice system. This expert repair work at reduced rates is another saving to the taxpayers in their road building.

The Equipment Division is under the supervision of Mr. A. W. Moffitt who has been in charge as superintendent since 1919.

EDITORIAL

ORGANIZATION AND THE ENGINEER

Probably the public is giving more thought to the "labor question" now than ever before; at any rate it seems so. It seems, also, that people are seeking the truth with unusual efforts to put prejudice aside. Very few people have reached settled convictions on the subject, but there are certain signs that out of all the deluge of discussion a few fundamental principles are being isolated and agreed upon. The engineer, standing between capital and labor and familiar with the ambitions and problems of each group is in a good position to assist in the establishment of equitable industrial relations, and he has no public duty higher than this.

To us it appears doubtful if society can continue to tolerate a condition where certain classes are organized while others remain unorganized. The statement that the American Union could not exist half slave and half free will be recalled. The truth of this statement was established. Is it equally true that society cannot continue to exist half organized and half unorganized? If it is, then one of two things must happen—either everybody must get into an organization to safeguard his selfish interests, or all such organizations now existing, whether of labor or capital, must be abolished by due process of law. It seems obvious that if all were organized there would be no advantage to any individual or class for the advancement of any group would immediately be nullified by the advancement of all other groups. At present there is an advantage in organization only because so many classes remained unorganized. The organized advance at the expense of the unorganized. Why should this be and how long can it continue? What answers will the engineer make to these questions?

REAL ENGINEERING COOPERATION

In a recent issue of the Journal of The Western Society of Engineers the following statement was made by an officer of the Society: "A member of a profession such as engineering should feel it his duty to assist fellow members in all matters relating to their professional advancement, as by so doing he contributes to the success of the profession as a whole." Probably all engineers will applaud this statement, but how many observe this precept as a guiding principle in their conduct toward other engineers?

We believe that one feasible plan for increasing the compensation of all worthy engineers is for the chief to advance his subordinates if he can and when he feels they deserve advancement. The chief engineer who considers it a major part of his job to keep down the cost of conducting his department and saves at the expense of all his men is holding himself down at the same time, for anything he does to cheapen the value of engineering service is bound to react on himself. If the chief is alert in the interest of his really worthy surbordinates he is looking after the best interests of his employer and himself.

MAKING ZONING PERMANENT

Zoning ordinances for the regulation of use, height and area of buildings are being adopted by cities in almost every state in the Union, and in some states where there is no specific authority for zoning these ordinances may be set aside by the courts. An enabling act is advisable in all cases.

A standard law for the assistance of those responsible for the framing of state zoning enabling acts has just been issued by the Department of Commerce, Washington, D. C. This model enabling act is a 20-page mimeographed pamphlet with foot notes covering questions which may arise in the wording of various sections and provisions. It should be noted that this is not a federal law but is a suggested form for state enabling acts.

Those who have made any sort of study of political reactions will probably agree that it is easily possible that a city might adopt a zoning ordinance and repeal it after a change in administration. In a year of discontent a mayor and council might be elected on a general "anti" platform including, incidentally, an anti-zoning plank calling for the repeal of the zoning ordinance. If the ordinance had been in effect for some years and had been accepted in good faith by many builders its repeal would work a real

hardship on them. As this, or anything else, can easily happen in almost any locality when made a political issue and joined with other issues in a manner to confuse the electorate, it seems very desirable to safeguard zoning laws and ordinances against easy repeal. It should be made very difficult to repeal zoning regulations, although their reasonable modification should be made comparatively easy.

An enabling act is always advisable. It is frequently assumed that the powers contained in Home Rule Charters are sufficient to enable a municipality to undertake zoning. This is often a mistaken belief and some zoning ordinances have been set aside because the municipality had not been granted the specific power to do what zoning implies.

It is understood that the Department of Commerce is now giving careful study and attention to a group of typical zoning ordinances and is considering the preparation of a standard ordinance or parts of ordinances. It is expected that a supplementary publication on this subject will be forthcoming.

AN EXPENSIVE SOURCE OF REVENUE

Some cities, desperately in need of money, have had recourse to a very expensive source of revenue in the shape of taxing visiting motor trucks. It is appreciated that the tax rate is high in most, if not all, cities and the hard pressed officials must cast about for additional funds with which to pay the cost of running the city without still further increasing direct taxation, and one can sympathize with them in their predicament without approving of all the measures they adopt. It is becoming quite common to require trucks to pay city as well as state taxes and there is something to be said for this practice so long as the cities extend reciprocal privileges to their citizens. But when a man drives into a strange city in a truck and is pulled from his seat and arrested unless he buys a truck license issued by that city we do not hesitate to denounce the practice as an abuse of power that is unwise and very short-sighted. A better way of turning business away from a city could not well be conceived unless the police force is directed to order pedestrians to "stand and deliver." The practice is so abhorrent to all recognized usages of commercial intercourse and so contrary to all emotions of neighborliness and hospitality that to be condemned it needs only be mentioned. Let it be said to the credit of "business men" that they appreciate the folly of this practice and have made such vigorous protests in some cases that it has been abandoned or greatly modified.

THE TEACHERS OF ENGINEERING

Before sending his own son to an engineering college the prudent man will give thought to many things. He will consider the general reputation of the college as an over all check on its worth and as presumptive evidence of the presence or absence of the various attributes a college should possess. He will consider the physical plant, the number, size and type of buildings. He will consider the laboratory equipment available, and, if a college man himself, he is likely to give consideration to the text books used. But any one of these conditions, or all of them combined, will not weigh as heavily with him as the personnel of the teaching staff. After all it matters comparatively little what the school is called or where it is located, whether it is old or young, large or small, but it matters greatly whether its teachers are competent or not.

Too often teaching is left to immature instructors or impractical men of greater age, while those on the staff who are best qualified to teach young men spend their time in administrative or research work, or in "outside practice."

There is only one way to make reasonably sure of competent instruction, and that is by paying salaries that will attract and hold real masters. A professor's salary should be high enough to enable him to have the material things essential to artistic success. It should be high enough to attract successful practicing engineers, who are willing to make some sacrifice in income in order to secure the advantages of life and work in a college community, but who are not tempted at all by the scale of compensation now in vogue.

We believe the time has come to stop the "competitive armament race" between colleges in buildings and equipment and to begin turning much of the money so saved into higher salaries for the teachers. It is well to remember, always, that to a young person his teachers are second in importance only to his parents.

ASPHALTIC CEMENT SPECIFICATIONS

By Gene Abson, Chief Chemist, Chicago Paving Laboratory, Inc., 160 North Wells St., Chicago, Ill.

The importance of rigid specifications governing asphaltic cement is oftentimes given too little consideration, due, perhaps, to the fact that the average sheet asphalt pavement contains only about 10 to 11 per cent, by weight, of bitumen. Although this is true, perhaps more importance will be attached to its value if it is borne in mind that when considered on a volumetric basis, as is the entire theory of asphaltic pavement construction, this same 10 per cent by weight represents more than 20 per cent by volume. It is generally conceded by authorities who have studied pavement failures, that but a small percentage of disastrous results can be attributed to actual inferiority of the asphaltic cement; however, it is likewise thought that a large percentage of incipient failures and cracking of mixtures, considered alone, can be traced directly to the absence of sufficiently rigid and essential requirements governing the asphaltic materials used.

Some Worthless Tests

An examination of specifications from representative cities throughout the country, with special reference to cities where pavement troubles have been encountered, shows a tendency towards neglect of certain standard requirements capable of insuring quality, with a substitution of arbitrary and practically valueless tests. These latter are usually the product of some more or less inventive mind seeking recognition by radical departure from previous practice, and with no apparent reason or foundation based on theoretical or practical consideration; failure or compliance with these requirements means nothing. Particular reference is made to various bending tests conducted at temperatures ranging from 0 deg. F. on up, and upon which few operators can obtain concordant results; "freak" penetration and ductility tests made at temperatures other than accepted standards and offering no means of comparison with materials which have heretofore proven successful. The gradual widening and elimination of requirements, if carried on too far, will in time allow a material to be used by stating that it shall be of such-and-such a proprietary name, without a word governing its chemical and physical properties, as has been noted in at least two instances. Examination of the asphaltic material used in one of the above instances in a Western city showed it to be of an exceptionally poor grade and unfit for use as a paving cement, but its rejection was impossible. The unwise acceptance of a specification such as this will undoubtedly be evidenced within a year or two.

Aim of Low Requirements

In this list must also be included specifications sponsored by manufacturers whose only aim is to keep the various requirements as low as possible in order to permit the use of all grades and forms of their material, regardless of whether or no they are first-class. The conscientious producer, of course, is to be considered when specifications are being written, but only insofar that no undue limitations are imposed which would be prohibitive from an economic standpoint without in turn increasing the merits of the material. However, from this angle only is the producer to be considered, and in no case should quality be given a minor consideration for the sake of allowing competition by the manufacturer of an inferior product.

The Evil of Closed Specifications

Then, too, there are specifications promulgated by producers which are so drawn as to exclude all but their own product, of which supply the producer usually has the monopoly. This practice restricts competition with other brands of proven and recognized merit, and results in an increased price of pavement to the taxpayer, as has been demonstrated innumerable times in cities in which the specifications are "closed." In some instances it has been found that this practice has been due to ignorance on the part of city officials, rather than a belief that a particular brand was superior in quality, or a willful attempt to prevent competition for ulterior motives. Oftentimes specifications are "closed" in effect, but not in the eyes of a legal advisor, whose interpretation of the legality of such a specification is based on the assumption that the existence of a small quantity of some material which will comply with the specification constitutes an "open" specification, irrespective of the availability of the material for practical competitive purposes or whether it be no more than a scientific curiosity. Nevertheless, in every instance it has been found that cities soliciting bids under "closed" specifications invariably pay more for the same type of pavement than does a neighboring city for the same

brand considered in competition with others under an "open" specification.

The writing of specifications and the limiting of requirements for asphaltic materials is predicated upon several important considerations, namely, a thorough knowledge of the chemical and physical properties of the various bitumens which are in use as a source of supply for paving cements; an investigation of both successful and failed pavements for the purpose of determining which failures are attributed to the cementing medium, and provision for adaptability of paving materials to a variety of traffic conditions.

Asphaltic Cement and Flux Oil

The only specifications which are necessary, so far as bituminous materials are concerned, are for the asphaltic cement itself, and those governing flux oil where refined asphalt is being brought to the proper consistency. Clauses governing the refined asphalt are unnecessary for the reason that the asphaltic cement is the major consideration, and compliance with the AC specifications precludes the use of none but good quality refined asphalt. However, it is imperative that flux oil be tested separately, especially when used in small quantities, as it is usually extremely difficult to detect by laboratory tests the presence of an inferior flux after combination. It is only after the pavement has been in service for several years that this inferior product will be revealed, often by excessive cracking.

Testing Asphaltic Cement

The only requirements for an asphaltic cement, which are really essential, are that it shall be adhesive enough to cement firmly together the particles of mineral; be ductile enough to withstand the effect of expansion and contraction without losing its cementitiousness; be capable of resisting extremes of temperature by not becoming too brittle or too liquid; and not be unduly hard nor lose its cementitiousness by the volatilization of lighter hydrocarbons; and, of course, be of the proper original consistency for the pavement contemplated. These requirements, if properly covered by rigid specifications, will insure an asphaltic cement which, if handled properly and combined with the right proportions of suitable filler and aggregates, result in none but good pavements. For the control of these properties no elaborate array of chemical or physical tests is necessary; only the following are considered as having any direct bearing upon the quality of the asphaltic binder:

1. Penetrations at 32 degs. F., 77 degs. F. and 115 degs. F., for the control of susceptibility to temperature changes.
2. Ductility, or cementing value, for cementitiousness and adhesiveness.
3. Flash and volatilization, for determining the presence and quantity of lighter hydrocarbons, which reflect upon the effect of time on pavements in service.
4. Solubility, for determining purity, and care used in refining.

Testing Flux Oil

If the flux oil is to be tested apart from the asphaltic cement, as is recommended where used, the only tests which are necessary are:

1. Flash and volatilization, as in asphaltic cement.
2. Solubility, as in asphaltic cement.
3. Specific gravity, for control work in fluxing.
4. Asphalt content determination, with ductility of resulting asphalt, for quality, as in asphaltic cement. (Applicable particularly to asphaltic base residuums.)

An important consideration in interpreting the ability of an asphaltic cement to bind securely together the mineral particles, and one which it is believed is not thoroughly understood and stressed, is its susceptibility to temperature changes, especially at higher temperatures approaching the approximate maximum of the summer sun on a pavement. At present, a susceptibility factor which is used in several laboratories is evaluated by a ratio factor between the penetrations at 32 degs. F., 77 degs. F. and 115 degs. F., and which has proven of considerable value. However, it is thought that this factor can be more definitely established by a comparison of ductility values together with penetration values at higher temperatures, and it is planned to investigate the matter more carefully and interpret the results on a practical basis.

Identification Tests

Other tests quite generally found in specifications, such as fixed carbon, specific gravity of the asphaltic cement, presence or absence of sulphur, paraffine scale, etc., are merely tests of identification for various bitumens, but bear no relation whatsoever to the value of the material as an asphaltic binder.

The Open Cup Recommended

In passing, it might be pertinent to point out that at present there seems to be a tendency towards the adoption of a modified open-cup method for determining flash points, this being brought about on account of the wide discrepancy and in-

ability to compare the results obtained in the various closed-cup methods now in vogue. It is strongly recommended that the open cup be used entirely, employing a modified Cleveland cup in the form of the regular 4-oz. deep style tin, filled to the beading, which allows ample room for expansion of the material and accumulation of the vapors. The advantages of this method are ease of operation, especially where a large number of tests are made daily, as each determination is made in a separate container and discarded after completion; greater uniformity and more concordant results between different operators, due to elimination of personal equation and standardization of equipment; ease of interpreting results when standard has once been adopted. Under present 'closed-cup standard methods, which require that container be filled to within 5 mms. of the top, a determination becomes extremely difficult on account of overflowing as the material expands, resulting in widely varying flash points upon the same material.

Importance of Flash Point

Regardless of whether natural petroleum asphalts, or refined asphalts and flux, are used, too great stress cannot be laid upon the importance of the flash point and the volatilization determinations at elevated temperatures. Under present traffic conditions, particularly in cities where the pavements are subjected to a considerable amount of swift-moving automobile traffic, it has become necessary to design pavements using a minimum amount of bitumen with a maximum amount of fine mineral, making no allowance for gradual drying out and hardening of the bitumen, as has been previous practice in the days of lighter traffic, when comparatively rich mixtures were laid. Such a pavement laid now would be impracticable for the reason that rolling, rutting and general distortion would take place before the drying and hardening action showed its effect. If the flash and volatilization requirements are not made higher than has been previous practice, when the lighter constituents have volatilized, the mixture hardens and cracks profusely. Therefore, it has become necessary to use an asphaltic cement or flux which has been refined to the extent that all of the lighter constituents have been removed. Proof of the protracted cracking which takes place when asphaltic materials containing light constituents are used, can be found in pavements of the larger cities.

CONSTRUCTION OF REINFORCED CONCRETE SECTION OF LEE HIGHWAY AT PULASKI, VA.

By G. H. Derrick, Civil Engineer, Pulaski, Virginia

The town of Pulaski, Va., has just completed a reinforced concrete road extending from Washington Ave. to Pierce Ave., parallel with and south of the N. & W. Ry., known as "Dora Highway," and constituting a link in the Lee Highway. It is 1,154 ft. long, 18 ft. wide, 6 ins. thick at the sides and 7 ins. thick at the center. A 5-ft. sidewalk with curb and 2-ft. gutter extends the full distance on the south side, and a 4-ft. shoulder of old macadam on the north side gives a 24-ft. roadway.

This section of road has been macadamized for some six or seven years, and has had considerable repair work done on it, including surface treatment. Owing to the poor drainage and adjacent low land, it has given more or less trouble in the upkeep.

The Town Council decided to put in something permanent, and accordingly had plans and specifications, with estimate, made, with a view of doing this work with the local help and under the writer's supervision. An old "Smith" mixer on skids, calling for three set-ups, with two-wheel buggies, giving an average haul of some 100 ft., was available. A 1:2:4 mix, 1-course concrete, was used, having a 4-in. crown; assuming 3.8 cu. ft. to 1 bbl. of cement and 45 per cent voids, 1.57 bbls. of cement, 0.44 cu. yd. of sand and 0.88 cu. yd. of stone to 1 cu. yd. of concrete, we deduced the following quantities per lineal foot: 0.36 cu. yd. of concrete, 0.1584 cu. yd. of sand, 0.3168 cu. yd. of stone, and 0.5652 bbl. (or 2.26 bags) of cement. From the above we estimated 432 cu. yds. of concrete, 678 bbls. of cement, 257 tons of sand and 513 tons of stone.

American Steel and Wire Co.'s No. 049 triangular mesh reinforcement was placed near the bottom, and Carey Elastite, ⅜x 6-in. in 9-ft. lengths, was placed next to the old curb and joints every 40 or 50 ft.

First the old macadam was rooted up and removed, then using the gutter edge on the south and setting a 2x6-in. form on the north to the same grade, and with a template resting on both, the grade was trimmed and rolled to the correct sub-grade. This gave the sub-grade a 3-in. crown. The forms were coated with auto oil secured at the garage from discarded washings of cars. A strike board was

made of three 1x10-in. boards spliced and shaped to the finished curve with a 4-in. crown, and shod with a strap iron, and suitable handles for the convenient handling by two men. As the concrete was placed, the strike board thoroughly tamped to the correct grade, bringing the moisture to the surface and forcing all stones down. This is very important to get a true surface, and cannot be neglected. The roller was made from a scrap 5-in.x5-ft. piece of steel pipe made into a convenient roller, with 20-ft.x¾-in. handle to be used from one side; this weighed about 75 lbs., and followed the tamping as soon as the concrete had gotten stiff enough not to roll out too much. This rolling forced down all small stone and left a wet mortar top. A 20-ft.x6-in. rubber belt then followed, first with one or two trips of zigzag 6-in. strokes, and lastly a final straight firm side stroke to the unfinished concrete. In case of a stop not requiring a Carey joint filler, the template was set and the concrete squared up. On starting again this board was simply removed, and the new work placed in contact with the old. As soon as the concrete had gotten sufficiently hard not to be defaced a few inches of dirt was spread over the entire surface and wetted. This wetting was kept up for about 10 days. After two weeks from the time the last concrete was laid the dirt was cleaned off and the street sweeper was run over the surface, and a good washing was given and allowed to dry over night. Then a treatment of Hard-n-tyte (magnesium zinc fluosilicate) was applied. First application consists of, by volume, 1 part of Hard-n-tyte to 13 parts of water—density 5½. Second application, by volume, 3 parts of Hard-n-tyte to 10 of water—density 15½. A Beaume Hydrometer was used to determine the density as noted above for each mixture; these were each mixed in conveniently placed barrels along the sidewalk and the solutions applied with buckets and brushes by hand. By the time the first application was placed (6½ bbls.), the far end was thoroughly dry and the second 4½ bbls. followed; 650 lbs. of the crystals were used, leaving about 75 ft. at the east end, with only one treatment applied. It was decided to leave this for a test to show the results.

The road was then opened to traffic just two weeks after the last concrete was laid, August 28, 1922. The actual concreting and moving was done in 10 days, and the best 10 hours' run was 147 lin. ft. The actual cement used was 666 bbls., or 57 sacks over the calculated amount for the exact number of square feet. It might be noted just here that the factor 1.57 bbls. per cubic yard is higher than most tables and that 1.48 is more commonly found for 1:2:4 mix and is more like a 1:2:3½.

The cost has been as follows:

666 bbls. of Cement	@	$4.00.....	$2,644.00
260 tons of Sand	@	2.10.....	546.00
520 tons of Stone	@	2.50.....	1,300.00
160 Labor	@	2.50.....	400.00
650 lbs. Hard-n-tyte		.....	200.00
1,800 ft. of ⅜x6 in. Carey joint		.....	200.00
5,400 lin. ft. 50-in. No. 049 Am. Steel & Wire triangular mesh reinforcing			400.00
Outfit and rental		.....	100.00
Superintendence		.....	400.00
Total		.....	$6,210.00

Number of sq. yds.: 2,308. An average price of $2.69 per sq. yd.

The sand came from bank near Petersburg, Va., anda was clean and coarse. S.G.=2.63, Voids=38.6%, Silt=0. Screen test showed: 46% retained on No. 20, 71% retained on No. 30, and 99% retained on No. 100. The stone was local clean, hard limestone from ¼ to 1½-in.

ORNAMENTAL STREET LIGHTING SYSTEM AT LIMA, OHIO

By Elmer McClain, Director of Public Service, Lima, Ohio

The citizens of Lima are very proud of their new ornamental street lighting system, which cost them about $200,000 and which is the most complete and up-to-date in the country. It comprises 1,245 units, extending over 16.2 miles of lineal length and covers the entire down-town business section of the city and four principal residence streets. Petitions have already been circulated by property owners for several extensions.

The plans and specifications were drawn by Mr. Herman Gamper, Consulting Engineer, of Columbus, Ohio, following an inspection by Mr. Gamper and the Director of Public Service of some dozen ornamental street lighting systems in cities of the Middle West. The installation includes an underground system for ornamental posts operated from a turbo generator equipment in the municipal pumping station through constant current 6.6 ampere regulating transformers.

One of the most interesting features of the new installation is the graduation of candle power, mounting height, and spacing, in accordance with the requirements of the individual streets. In the public square the posts are 15 ft. high, with 1,000-candle-power lamps with special refractors, throwing the light toward the center of the square. On the main business streets they are 13 ft. 3 ins. high,

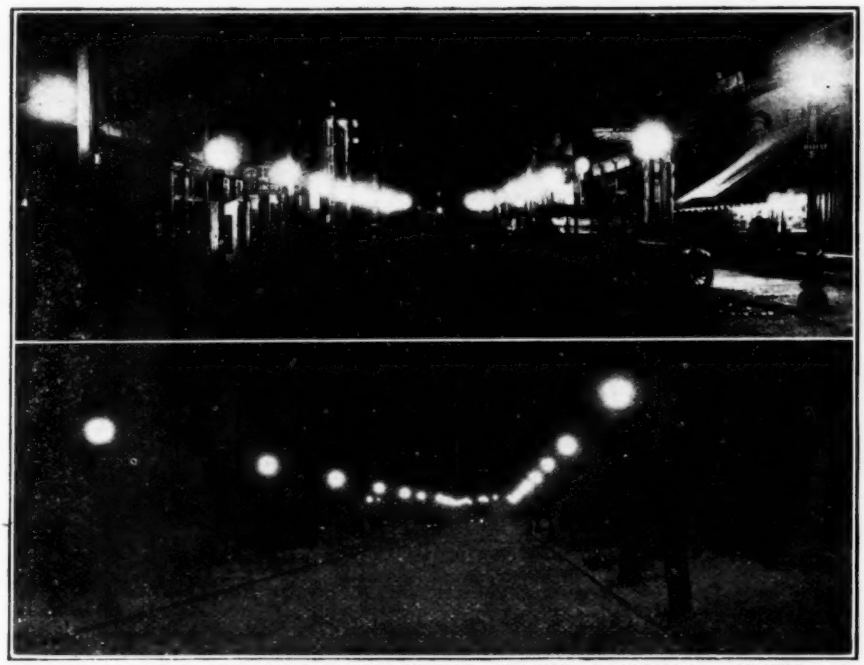
with 400-candle-power lamps. On the minor business streets and in the residence sections the height of the posts is 12 ft. 3 ins., and they are equipped with 250-candle-power lamps. In the down-town business section the standards are spaced 50 ft. apart. In the balance of the system the spacing is 100 ft. Much time and thought were devoted to the spacing and location of standards. Against the usual requests of individual property owners for the shifting of location, which has resulted in bad distribution in illumination in many cities, the Director of Public Service took a firm stand and insisted that each standard should go in as planned. The result is that the protesting property owners, as well as the citizenship generally, are delighted with the appearance of the entire layout and the uniform distribution of illumination.

In designing the installation the consulting engineer did not make the mistake of endeavoring to save on the maintenance of the units by cutting down the candle power of the lamps. This is poor economy in ornamental street lighting, because the saving in expense by the use of the lower candle-power lamps is very small as compared to the initial outlay for the installation, which remains practically the same for all candle-power lamps.

The contract for the construction work was let to the Northern Electric Company, of Columbus, Ohio, after very lively competition among some fifteen well-known bidders. In the installation, Hazard steel-taped lead-covered cable, for the underground system, and single conductor rubber covered and braided cable for the post wiring, were used.

Westinghouse-Cutter Continental posts were selected, equipped with Sol-Lux tops and Monax diffusing glassware. The lamps for 400-candle-power and upwards are operated through auto transformers in the capitals of the posts, and the 250-candle-power lamps are equipped with Regent "C" repeating film sockets.

The system, which is divided into 10 circuits, is operated from a turbo-generator set, supplemented in reserve by a Ball engine-driven 150-k.w. generator, in the city pumping station, through ten 34-kv-a Westinghouse constant current regulating transformers. Two circuits, extending throughout the system, including



TYPICAL VIEWS OF NEW ORNAMENTAL STREET LIGHTING SYSTEM AT LIMA, OHIO.

Business Street with Sol-lux Senior Tops on Continental Posts, 50 ft. Spacing, 400 C. P. Lamps with Auto Transformers. Cable in Sidewalk Just Inside Curb. Lima Makes Own Power and Uses Westinghouse Regulators and Lamps.—View on a Residential Street.

street intersections and the intervals between and alley intersections, are on all night. The remaining light circuits are turned off at midnight. During December, 1921, the consumption was 57,000 KWH.

A disconnecting pothead is installed in the base of each post, whchi, in the event of a post being accidentally broken, automatically disconnects the broken post, short-circuits the line, and leaves the rest of the lamps burning.

Westinghouse type "C" Mazda lamps are used throughout the system.

The alley intersections are lighted by special brackets, attached to the corners of the buildings, equipped with radial bowl street hoods, and operated from the underground system through safety coils. By this new installation, the necessity for unsightly overhead equipment has been eliminated, thus adding greatly to the appearance of the streets, hitherto cluttered up with overhead pole line equipment.

The impression of the graduated and harmonious illumination is very pleasing, and the stranger is able immediately to distinguish the importance of the various streets from the intensity of illumination.

STRENGTHENING GRAVEL ROADS WITH TAR SURFACE TREATMENTS AT ELGIN, ILL.

By Geo. E. Martin, Consulting Engineer, General Tarvia Department, The Barrett Company, 40 Rector St., New York, N. Y.

Elgin, Ill., is a thriving manufacturing and trading city of about 30,000 inhabitants, located some 40 miles west of Chicago. Elgin Township surrounds the city, and the major portion of the traffic in and out of the city of Elgin passes over the Elgin Township roads.

For a number of years this township has built gravel roads of pit-run gravel, which has been screened to remove the larger stones. The material as finally placed on the road ranges in size up to 1½-in., and contains a fairly large proportion, probably 30%, of material below ¼-in. in size. These roads have been built and maintained as plain gravel roads for several years, and the thickness of the gravel coating will vary from 8 to 15 ins. Up until a short time ago the gravel roads were maintained by the use of drags and blade graders. A new layer of gravel 2 or 3 ins. thick was placed on them every one or two years.

In 1920 Mr. Charles Burnidge, Township Road Commissioner, decided that he would try to use some sort of bituminous material on the gravel and maintain them as gravel roads with a bituminous crust or top. Previous to this time he had used dust-laying oil, and while it was successful in laying the dust, it did not strengthen the surface of the road, and Mr. Burnidge wanted something that would carry the heavier traffic in a more satisfactory manner.

Two roads, the St. Charles Road and South Street Road, were chosen for experimental work for the summer of 1920. Each of these roads was given an application of ¼ gal. per sq. yd. of Tarvia B in June, 1920. Because of the small amount of material used, the actual results obtained were only fairly good, but they were encouraging enough that the Township Road Commissioner was willing to go ahead and carry through this work in the season of 1921.

The St. Charles Road was scarified, reshaped and rolled early in 1921. It was left under traffic for about 4 weeks before it was treated. The South Street Road was not reshaped, but was simply left under traffic for this period. In June and July, 1921, the St. Charles Road was given two applications of ¼ gal. each of Tarvia B. The same treatment was applied to South Street, Dundee Ave., Highland Ave. and Kenyon Road. The time between the first and second applications of the Tarvia B was in some cases less than 24 hours, and in some cases was approximately 48 hours. The roads were closed to traffic while the Tarvia was being applied, and for the period between the two treatments. A cover of clean pea gravel using 1 cu. yd. to about 90 sq. yds. was applied soon after the second application of the Tarvia B. Immediately after the application of the cover the road was thrown open to traffic. No cover was used on the first application of Tarvia B.

Before the Tarvia B was applied the road was swept with a rotary horse-drawn sweeper. This work was done very carefully, so as to get practically all of the loose material removed from the surface, and still not disturb the bond of the road proper.

Preliminary preparation of the roads to be treated was started during the fall, and continued during the spring, when the roads were soft. The roads were gone over at frequent intervals with a light grader and all of the loose material worked toward the center, where it would be consolidated into the road by traffic. In some cases the crown is still somewhat

high for a bituminous treated surface, but because of the condition of the road it was not possible to remove all of the excess crown.

The 1921 surface treatments were entirely successful, and carried the traffic through the summer. In all, about 7 miles of 18-ft. gravel road in Elgin Township was treated with Tarvia B in the season of 1921.

During the summer these treated roads were maintained by a patrolman. As soon as a break in the Tarvia B surfaces appeared it was immediately repaired with Tarvia KP. In almost all cases the repair was made by brooming the Tarvia KP into the broken spot and covering it with pea gravel. By carrying on the work in this way and repairing the breaks as soon as they occur, it has been possible to carry the roads through with very few deep holes. Where deep holes have occurred, however, a mixture of Tarvia KP and gravel has been used for making the repair.

In practically all cases these roads have come through the winter in good condition and will not need to be reshaped before being given a surface treatment with Tarvia B this season. In case, however, the road does show considerable breaking up in the spring, it is an easy matter to break up the road with a scarifier and shape it down and permit it to consolidate under the traffic. When it is thoroughly consolidated it is then given a single treatment of ¼ gal. Tarvia B, covered with pea gravel, and is then in good condition to go through another year. Several new roads will be added to the list in Elgin Township this year, and it is expected that by the end of the season there will be 12 or 15 miles of Tarvia B surface treated gravel roads 18 ft. wide in Elgin Township.

By treating the gravel roads in this way it has been possible to carry heavy automobile traffic over the roads built of ordinary pit-run gravel, and to do this with but little inconvenience to the traffic, for the treatments give a hard, dustless, bituminous surface for traffic during the summer. This work in Elgin Township has been treated as a maintenance proposition, as it should be, and the gravel, after being treated, has been taken care of just as thoroughly as an ordinary, untreated gravel road. If the work is carefully done and the maintenance is properly carried out, it is possible to carry traffic up to 2,000 or 3,000 vehicles per day in a very satisfactory manner over these strengthened gravel roads.

Considerable credit is due Mr. Burnidge for the way in which he has solved the rather difficult road problem in Elgin Township.

DRAINAGE EXPERT DISCUSSES HIGHWAY AS COMPARED WITH AGRICULTURAL DRAINAGE

By Edgar A. Rossiter, Consulting Civil Engineer, 127 N. Dearborn St., Chicago.

As we read the articles by various highway engineers relative to drainage, the thought comes that perhaps a treatise on drainage, both surface and sub-surface, applicable to highway construction, would not be amiss.

When the subject first came to my notice I thought that the reason the highway engineer was averse to drainage was simply a question of the cost, and for that reason the writer "butted in" to aid them in convincing their superiors that drainage was necessary, but their various articles and speeches lead me to think that they have not availed themselves of the mountains of data pertaining to drainage, printed by many of the State Experimental Stations and the Federal Government, or they have been unable to assimilate the great fund of information given through these channels, and they are promulgating theories that are diametrically opposed to those that are published by the very States that employ them.

Every drainage expert is familiar with hydroscopic, capillary and gravitational forms of soil moisture and their characteristics under certain methods of drainage, and he knows further that he may so design his drainage system as to destroy the very object he seeks to attain. The expert drainage engineer, in designing a farm drainage system, plans his work and the depth of his tile in such a manner as to aid capillarity. If he wants a bone-dry drainage he places his tile deep enough to kill capillarity. In fact, there is more to drainage than just to design a conduit of proper capacity to carry off the surplus water. In defense of my position I shall quote from Bulletins of the Iowa and Kansas Experimental Stations, United States Geological Survey, "The Principles of Soil Management," by Lyon and Fippin, and other authorities.

Iowa Bulletin 50, page 7, says: "The underdrainage systems of Iowa are constructed primarily in agricultural lands to increase the potential production of those lands. The study of soils and soil mois-

ture and their relation to crop production is essentially agricultural, but the relation of these to drainage is a part of drainage engineering, and a knowledge of them is essential to the engineer employed in underdrainage work."

* * * * *

"The proper spacing and depth for lateral underdrains are dependent upon the amount of the surplus soil moisture and the rate of its movement through the soil. These, in turn, are dependent quite largely, in each locality, upon the character of the soil. The same principles which determine the proper spacing and depth for the lateral underdrains also determine the rate of run-off from these drains, and a correct understanding of these principles is dependent upon a general knowledge of soils and soil moisture."

* * * * *

"Each different soil area has its peculiar properties and each presents a different problem in drainage, due, primarily, to differences in topography and the physical or mechanical composition of the soil."

* * * * *

"The agriculturist, in considering the physical properties of the soil of any region, will divide his information into that relating to the top soil, or the seed-bed of cultivatable crops, and that relating to the subsoil. The drainage engineer may or may not divide the soil in this way, depending upon the thickness of the top layer of soil. If this surface layer is 4 or 5 ft. thick the lower stratum will have little effect upon the underdrainage unless its perviousness or imperviousness be extreme.

"The drainage engineer will look rather upon the soil as a whole, and base his conclusions upon its general physical properties, considering, of course, any unusual formations. In some cases he may need to consider more than two layers or strata. The drainage engineer should not ignore the study of the agricultural possibilities of the soil in any proposed drainage district, because upon this will usually depend the feasibility, from an economic standpoint, of the proposed work."

* * * * *

Soil Moisture

"In discussing soil moisture and its movement only such phases of the subject as have any special relation to underdrainage will be considered. The subject in its entirety is so complex that only an elementary treatment is either possible or desirable here."

Forms of Soil Moisture

"Soil moisture is of three different classes: 1. Gravitational water, or that which is free to move under the influence of gravity. 2. Capillary or film moisture, which is held, by surface tension, against the influence of gravity. 3. Hydroscopic moisture, or that which condenses from the atmosphere upon the surface of the soil particles."

* * * * *

Gravitational Moisture

"Land drainage has been aptly defined as the removal of the surplus moisture from the soil. Usually this is only the means to an end, as the benefits of drainage are due to those actions made possible by the removal of the surplus moisture. Underdrainage is the removal of this water by artificial or natural means under the surface. As it is only gravitational soil water which is free to move under the influence of gravity, and which is unavailable for and injurious to plant growth, the need for drainage is proportional to the amount of this form of moisture present in the soil."

* * * * *

Watertable

"The surface of the gravitational water in the soil, or the surface of the saturated layer, is commonly called the watertable. It is also referred to as the ground-water level, ground water in this sense meaning gravitational soil moisture, or surplus moisture."

* * * * *

Capillary Moisture

"Insofar as plant life is concerned, this is the most valuable form of soil moisture and, in fact, the only form which is available for the sustaining of plant growth. It is held against the force of gravity, in the small pore spaces between the soil grains and as a thin film surrounding each individual particle or group of particles. It is the surface tension which holds the capillary water in the soil."

* * * * *

Available Capillary Moisture

"However, not all of even the capillary moisture is available for plant use. A certain portion of it is held so intimately that the small roots cannot draw it from the soil. This fact is illustrated by the data in Table A, which is compiled with data given in Lyon and Fippin's 'The Principles of Soil Management.' The value in the column headed, 'Approximate per cent of Moisture of which Crops will Wilt,' are the amounts of water which are

TABLE A

Kind of soil	Dry porosity per cent	Approximate per cent of water crops will wilt	Available moisture depth inches in top 4 ft.
Dune sand	52.2	3.0	4.6
Coarse sand	51.0	3.0	5.2
Fine sandy loam..	50.0	5.0	8.5
Silt loam	50.0	10.0	6.9
Clay	59.0	17.0	7.0
Muck soil	80.0*	80.0	20.5

*Assumed.

TABLE B

Per cents of Hygroscopic moisture at 21° or approximately 70°.

Very fine sand.....	1.8 per cent
Silt	7.3 per cent
Clay 16.5	per cent

held so intimately in the soil as to be unavailable for plant use."

Hygroscopic Moisture Content

"The amount of this form of moisture in a soil is a function of the surface area exposed and consequently is greater in the finer grained soils. The amount also varies inversely as the temperature in the soil. Table B shows the amounts of hygroscopic water held by three soils, each of which was a soil separate obtained by careful analysis.

* * * * *

Comparison of these data with others in the text from which these were taken show that all soils hold a considerably larger percentage of capillary water than of hygroscopic water. The importance of this form of moisture is further reduced by the facts that it is varying in amount and unavailable for plant use. It has practically no bearing at all upon the underdrainage of the soil.

* * * * *

Forms of Soilwater Movement

The previous discussion of the types of of soil water will readily suggest the forms of soil-water movements. Each of three forms of soil-water has a distinct type of movement:

1. Gravitational, or the movement of gravitation water under the influence of gravity.

2. Capillary or the movement of capillary moisture due to capillarity of surface tension.

3. Thermal or the movement due to changes in temperature. This latter movement is in the form of water vapor, though changes in temperature have some effect upon the other two types of movement.

* * * * *

Thermal Movements

This movement takes place as the movement of water vapor and consequently is relatively very small.

* * * * *

Evaporation

Evaporation of soil moisture may take place not only at the surface as is popularly supposed, but also in the deeper pores of the soil.

* * * * *

Capillary Moisture and Drainage

Capillary moisture has no direct relation to underdrainage though it has a very definite and important bearing upon the results and effects of drainage. When the plane of saturation is lowered by the use of underdrains the moisture necessary for crop production must be supplied by capillarity.

* * * * *

Capillary Movement

In the discussion of capillary soil moisture its importance to plant life and its relation to underdrainage were explained. Its movement naturally bears the same relation to these as the moisture itself. It is of vital importance to crop production but of very little importance to the operation of underdrainage.

* * * * *

Form of Movement and Factors Governerning It

The form in which capillary moisture occurs in the soil is a thin film of moisture surrounding the individual soil particles. Its movement then is a film movement and depends upon an unbalanced condition in the pull exerted upon these films. Any moisture which is moved in this way naturally moves as a film and consequently is small in amount. This movement always takes place from the wetter soil to the dryer regardless of the direction.

TABLE C Moisture Content of Soils

Kind of Soil	Weight per cubic foot, pounds	Pore space per cent	Maximum water capacity per cent	Maximum capillary capacity per cent	Maximum gravitation capacity depth inches in top 4 ft.	(per cent)
Dune sand	80	52	40.5	10.7	18.3	29.8
Coarse sand	81	51	39.5	10.6	18.0	28.9
Fine sandy loam....	83	50	38.0	18.0	12.7	20.0
Silt loam	83	50	38.0	20.9	12.1	18.9
Muck soil	15	80	333.0	250.0	9.6	83.0
Clay	68	59	54.5	30.4	7.3	13.9

The soil factors governing this movement are texture, structure and dampness. The finer the soil particles the more surface is exposed and consequently the greater capillary pull is exerted. In general it may be said that the extent of capillary movement is inversely proportional to the fineness of the soil grains. It is also true that when the soil grains are very fine the spaces between them become so very minute and the thickness of the film of moisture so reduced as to increase the friction and make the movement very slow. It is also necessary for water to wet any substance to which it is held by capillarity, hence if the soil particles are somewhat dry the moisture is not held to them strongly until they become damp, as all natural field soils have a certain resistance to wetting. The rate and extent of this movement are also affected to some degree, by the temperature changes. The surface tension is greater for low temperatures than for high, causing both a greater rate and a greater extent of movement at the lower temperatures. On the other hand, warm water is more limpid than cold and will consequently pass through the small pore spaces more readily.

* * * * *

Relation of Capillary Movement to Underdrainage

The most important phase of this movement in relation to underdrainage is the distance which a sufficient quantity of water for crop production will be raised. It is the effect of any drainage to lower the permanent water table after which the moisture for sustaining plant life must be furnished capillarity. If the water table is held at too low a stage an insufficient amount of moisture will be raised to the upper soil layers and the crops may suffer. In such a case the underdrainage system will have been too effective and its results will be no better than those conditions which obtained before any drainage was attempted.

* * * * *

Rate and Extent of Capillary Movement

As has been stated the rate and extent of capillary movement depend upon the distance the water is raised and the nature of the soil through which the movement takes place. In part two of the Nineteenth Annual Report of the United States Geological Survey, is given experimental data from which Table E was compiled. These data illustrate the principle that the rate of movements varies inversely with the extent and distance of the movement. The lower rate of movement in the clay soil from each lift is probably due to the greater friction and greater resistance to movement in the finer grained soil.

* * * * *

The report referred to indicated that for natural field soils the movement is fairly rapid when the lift does not exceed 4 ft.

* * * * *

Capillary Movement and Depth of Underdrains

From the standpoint of the supply of capillary moisture the above data indicate that the ideal underdrainage system for the average Iowa soil which is to be used for the ordinary field crops is one which will maintain the groundwater level at a depth of from 2.5 to 3 ft. below the average elevation of the crop roots. However, this depth varies slightly for the various crops and soils. The depth seems to afford the maximum storage capacity without so lowering the watertable as to reduce the capillary movement too greatly. There are, however, other factors than the supply of capillary moisture which must be considered in determining the depth of underdrains.

The gravitational movement is the result of the gravity pull upon the soil water, and, as both the capillary and the hygroscopic moisture are held against gravity, it is only the gravitational soil moisture which is affected. This moisture and its movement are usually referred to as "groundwater" and groundwater movement or "percolation."

* * * * *

Effect of Soil Texture

The influence of the texture of a soil upon the movement of groundwater is due to the variation in the size of the soil pores resulting from differences in the sizes of soil grains. The finer the soil grains are the smaller the pore spaces and, consequently, the higher the resist-

TABLE D

Gravitational water capacities of soils near Hanford, Cerro Gordo County, Iowa.

Kind of Soil	Depth of sample below surface	Gravitational water capacity per cent
Black top soil.....	3 ins.	18.5
Clay, a little sand..	2.5 ft.	8.5
Whitish yellow clay	3.5 ft.	2.5
Blue clay	4.5 ft.	6.6
Sandy clay	3.0 ft.	13.9
Sandy clay	4.0 ft.	18.6

TABLE E

Pounds of water per day per square foot of soil raised from different depth.

Soil	1 ft.	2 ft.	3 ft.	4 ft.
Medium fine sand.	2.37	2.07	1.23	0.91
Medium clay loam	2.05	1.62	1.00	0.90

ance which they offer to the passage of percolating water. The rate of percolation varies directly as the size of the soil grains until in some very fine grained soils the pores become so small as to be completely filled with capillary moisture.

* * * * *

The Viscosity of the Moving Water

The effect of temperature upon the movement of gravitational water is of considerable importance. The viscosity of water decreases as the temperature rises, and consequently, the flow increases with the temperature of the water. Hazen found in his experiments with filter sands that the relative flow at different temperatures varied from .70 at 32 deg. to 1.0 at 50 deg. and 1.45 at 77 deg.

* * * * *

It has become quite general practice to design underdrainage systems in which the laterals are placed 4 ft. deep and 100 ft. apart.

In close soils or in average soils to be used for truck crops this spacing should be decreased to 75, 50 or even 33 ft. as the conditions demand.

When moisture is to be supplied by capillarity, as is the case during periods between rains, the lift should not exceed 2.5 to 3 ft. if the crop is to be fully supplied.

From an agricultural standpoint the proper depth of tile in sand is 2.5 to 3 ft., the capillary capacity being 10 per cent, 1 8/10 per cent is hygroscopic moisture.

In clay the depth of tile should not exceed 4 ft. deep, the maximum capillary capacity being 30 4/10 per cent of this, the hygroscopic water is 16 5/10 per cent, leaving 13 9/10 per cent of available moisture. Therefore in ordinary soils there is a limit to the capillary force or suction and when you exceed that limit, capillary flow ceases, the depth at which the force ceases varies in the different soils. In highway drainage the scheme is to lower the surface of the ground water to a point where the water table between two drains is below the capillary suction.

To obtain the best capillary results in clay soils the tile should be placed 33 to 36 ft. apart and not to exceed 3.5 ft. to 4 ft. deep, and I will venture to state that in 99 per cent of tests, made by highway engineers, the tile have been so placed and then the engineer rushes into print telling of the failure of drainage in highway construction and even to the fact that "there was less than 6 per cent difference in moisture content in drained and undrained roadways," "therefore drainage was a failure." Let us see where the water table of his groundwater was under these conditions, which are ideal from the agriculturalist view, and we will turn to page 38 of our Iowa Bulletin Number 50, and to the 1912 issue of Kansas Land Drainage, by H. B. Walker. (Figure 1.)

A and C are two tiles 4 ft. deep in clay soil, spaced 36 ft. centers. D is the groundwater or water table during wet season. E is the water table at the dry season. D is 11 ins., and E is 2 ft. 5 ins. below the surface of the ground (ideal conditions for the farmer), but these same tile might just as well be hung on the telephone poles for all the good they do the high-

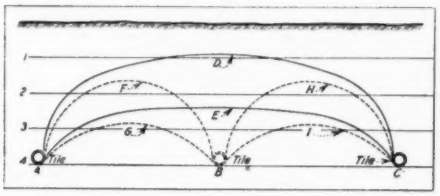


FIG. 1.

way because the peak of the groundwater is under the center of the roadway, and during the winter the frosts would heave the pavement and during the spring floods the pavement would be floating on a sea of mud.

Suppose we placed a tile at B then the water table would be lowered to F and H at flood time and G and I in dry weather, let us then lower the tiles A, B, and C until G and I would be 4 ft. below the surface. A, B, C are 18 ft. apart, capillary action ceases to be as strong and if under a pavement with subgrade properly rolled, capillary suction sealed off, by reason of the sub-soil being rolled to imperviousness, you then can obtain a bone dry subgrade, the opinion of several writers to the contrary notwithstanding.

There seems to be a peculiar understanding among engineers, both drainage and highway, as to the full effect of a well-designed drainage system as to spring conditions of highways, as well as field drainage. The Westmoreland Drainage District, comprising some 2,500 acres of extremely flat lands, has a 2 ft. top soil of black sandy loam, 6 ft. layer of sandy clay to hard-pan. The outlet tile runs through a 15 ft. ridge of hard-pan into the river. This outlet tile is placed in the road ditch for about one mile, there have been no chuck holes or heaving in the roads since the tiles were placed, water runs in the tile at the outlet 2 and 3

ins. deep in mid-winter at 22 degs. below zero.

Every foot of this drainage district is dry and the frost goes to 5 ft. depth in winter. The first spring rain and often the January rains melt the top crust of damp frozen soil and the water passes down through the drained soil and not over the top as some engineers would insist that it should, or in other words the capillary and hygroscopic water when frozen do not close all the pores in a well-drained soil.

In view of the fact that some of our highway engineers have publicly stated that tile drainage is of no value and that open ditches are better, I wish to state that an open ditch is only good when cleaned out, is free from weeds and other impediments and then only during the summer months. During the fall and winter the dead leaves, ice and snow form barriers and in the early spring when most needed is in no shape to free itself much less the adjacent lands. A shallow ditch will drain the surface only, a deep ditch is a menace to life and property and rarely is in good condition over ten months of the year.

Let us see what Kansas has to say about open ditches, Fig. 2 is a copy from its 1912 Bulletin, page 43.

"Impervious soils retard the free percolation of water by gravity and also prevent lateral movement of soil moisture."

Fig. 2, shows an average section of soil. This is a good example of what the highway engineer meets in every day construction. We will assume that the ditch is 4 ft. wide and 3 ft. deep and scale an 18 ft. roadway thereon. It is quite evident that unless some method is used to cut through the impervious sub-soils that the pavement is going to be laid in a sea of mud, and though the engineer put a ditch on both sides of his road and roll his sub-grade, he still will have his water pockets to heave his roadway during the winter. It must be remembered that ditches are for surface drainage and except in sand and light soils the water table is the surface of the ground. I have dug deep ditches within 10 ft. of a pond and not lowered the level of the water a quarter of an inch.

There has been much said and printed relative to rolling the sub-grade. I believe a sincere study of soil structure might change the ideas of a vast extent of those who state certain presumptive ideas of their own as facts and wind up with the sad theory that "no solution is obvious." In my limited railroad experience the excuse railroad engineers give for construction of roadbeds 4 or 5 ft. above the surrounding terrain was to get above capillary flow and to obtain a reasonably dry sub-grade to ballast the tracks, and if such is not obtained the ballast will roll and disappear into the sub-grade.

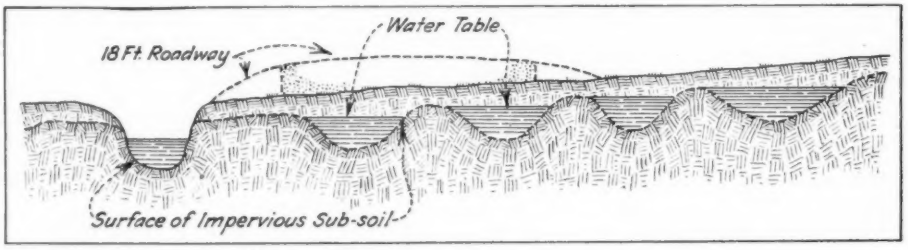


FIG. 2.

I would be pleased to go into the details of rolling sub-grade at some later date at which time I may also explain the value of hydroscopic water and its use in making soils impervious. As early as 1908 I prevailed upon a tile company to manufacture an extra heavy shale tile to be known and used as Road Tile. There is a difference in tile and Iowa has made some interesting tests of tile. The University of Illinois has published a number of reports relative to concrete and every engineer should read them before making doubtful statements.

TAR SURFACE TREATMENT OF GRAVEL ROADS IN MAINE

By Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, Maine

For the last eight years the Maine State Highway Commission has been surface treating gravel roads with success. During that time we have used exclusively a refined tar product suitable for cold application.

I believe it may be of interest to relate

some of the experiences from which our standard practice in the surface treatment of gravel roads with bituminous material has been developed.

Early Experiences

Some eight or nine years ago when we first tried these treatments the principal use of surface applications was for the purpose of allaying dust. Light asphaltic oil, known as "45 percent oil," was generally used for that purpose. The real effect of the oil always appeared to me to be merely to load the dusty surface particles of the road with so much weight that when stirred up by passing traffic these particles did not rise very much above the road surface and consequently were blown and moved around much. Naturally, we more or less followed in our early tar applications methods in vogue at that time. We attempted to get a true crown on our gravel roads by adding 1 in. or 1½ in. of new gravel where necessary and then by the use of a drag or light grader truing up the surface before the application of the bituminous material. The first year this work was done on any scale we applied our bituminous material in two applications. In May we used about 0.4 gal. to the square yard and about the first of August retreated all of these surfaces with an additional 0.2 gal. per square yard. Treatment was laid only 10 ft. wide. The real thing we sought to do with this treatment was to bond the loose surface material to the tightly bonded surface below it, and we fairly well accomplished this result.

By the end of the season, however, we observed that on certain sections of our roads so treated there was a slight rippling and waving of the surface. It occurred to us that this might be on account of the fact that we had not secured an effective bond between the loose surface particles of the road and the tightly bonded gravel beneath. In other words, the material which had been impregnated with tar had laid more or less as a mat upon the surface and, not being sufficiently filled with mineral aggregate, had pushed.

We had obtained, however, a much more satisfactory surface, generally speaking, than we had ever before seen on any surface treated road. The good sections presented the appearance of a first-class bituminous macadam surface, tightly sealed, smooth and dustless. As might have been expected, the edges of the bituminous treated section sheered off and crumbled away on account of so much traffic turning out for meeting and passing.

Cleaning Gravel Before Applying Tar

Our next development was an attempt to clean the gravel surfaces before the application of the tar. This was accomplished by the use of graders and drags and later by using a street sweeper and finally by following that with hand sweeping. We also increased the width of our treatments to 15 ft. We found that all of these steps gave us a much improved surface, and, in fact, since the first year we have used tar we have never made but one application to any gravel surface during a season. No sand covering was used during our first two or three years of treatment. The tar was applied on warm dry days from an automobile tank distributor under pressure and we just allowed the tar to lie on the road until it was absorbed and took its set.

Treating One Side of Road at a Time

Needless to say, we had much complaint from the traveling public on account of the dangerous condition of a freshly tarred surface for rubber-tired traffic. We attempted to obviate this danger as far as possible by treating one side of the road at a time. We would do a considerable stretch of road, anywhere from 6 to 10 miles long, and treat it on one side only. While the treatment was being put on the first side the other half of the road was left open for traffic and by the time we had the first half finished the tar that had been first laid was well enough set so that traffic could go on it. Then the other half of the road would be treated in the same way.

We observed, of course, that steel-tired traffic, wherever it ran on the freshly tarred surface, stripped the bituminous material from the surface. This made it necessary to do more or less patching by hand. Also, on account of the increasing automobile traffic, which was continually getting on to the freshly tarred surface, we found it necessary to sand the tarred surface a few hours after application.

Immediate Sanding

For the last three or four years we have made a practice of treating all of our surfaces 18 ft. in width, which has practically obviated the necessity of any patching on the shoulders or edges of the treated surface. Eighteen feet in width, which, by the way, is our standard width of pavements and hard surfaces today, affords a good double track way. We have been following the practice during the last three or four years of immediately covering the bituminous

material with a light application of sand. By immediately, I mean that within 5 to 10 minutes after the distributor has delivered tar to the surface of the road is has been covered with sand.

Procedure in Sanding

There are one or two points about sanding that I think should be spoken of. We place the sanding gang at intervals of 150 to 200 ft. apart, according to the length of road that the tank of tar will cover. Immediately the tar tank has passed, these men begin to sand, and the sanding is started at the center of the road and first a place is made where passing vehicles may turn out on the freshly tarred surface. This affords traffic meeting places at stated intervals, so that with careful driving it is not necessary for a vehicle to become smeared or spattered with tar or to take the risk of skidding incident to driving on a freshly tarred surface. Our sanders are also instructed to keep an eye to the traffic so in case anyone gets into difficulty we will have some witness as to what actually happened. These men also more or less caution drivers to be careful. Where we are applying tar over a summit grade we always plan to have a sander stationed at the summit to keep an eye to passing vehicles and to warn them against collision. These are points we have learned from experience and we have found them to pay. I offer the suggestions for what they are worth.

Maine Standard Practice

I might say that in general we have developed the following standard practice: As early as we can get on the roads in the spring, that is, when the roads begin to settle and dry out after the frost has left them, we begin shaping with the road grader. The roads are carefully watched during the two or three weeks while they are settling and are shaped either with a drag or blade grader several times if necessary to have them settle with as true a contour as possible.

The next step in our surface treatment is to draw out sand, which is left on the shoulder of the road in piles of about a quarter of a yard every 25 ft. Generally speaking, we use about 50 yds. of sand to a mile for cover. We use less sand, however, on a brand-new treatment than we do on re-treatment. Sometimes as little as 30 yds. to a mile is used on the original treatment. Re-treatments will take from 40 to 50 yds. per mile, as the tar has less opportunity to penetrate into the surface of the road.

The next step is to clean the surface of the road of all loose material. If a pocket of sand, dust or stone is left on the surface we are absolutely sure to have the treatment break over that pocket in a short time after application. This cleaning is done by the use of a street sweeper behind a light truck and if further cleaning is necessary after the sweeper has finished this is done by men with push-brooms.

Then comes the tar distributing gang, which is equipped with Kinney pressure distributors mounted on 3½-ton trucks. We have limited ourselves to this size of equipment because it is as heavy as our roads, generally speaking, will carry. We have a law which limits the gross weight of load to 9 tons, and I am free to say that one of these 600-gal. tanks filled with bituminous material will a little exceed the limit set up by statute for the gross weight of load. Under average conditions one tank truck will spread about 2,500 gals. of tar per day.

We still hold to the practice of tarring one side of the road at a time, and several days may elapse between the tarring of the first side and the tarring of the remainder of the road. As previously pointed out, immediately after the tar is applied a light sanding is given. We put on just enough sand fairly to blot the bituminous material and keep it from running off the crown of the road to the edge.

The surface is carefully watched for three or four days and if evidence of bleeding shows up, spots where this occurs are treated with more sand. Sometimes after a treatment has been down for two or three weeks an extremely hot day will start a little bleeding. This is watched carefully by the patrolmen and the same treatment of light sanding given.

In the treatment of new gravel surfaces, that is, surfaces which have never received a treatment before but which may have taken traffic anywhere from two to four or five years with an occasional resurfacing of gravel, we use not to exceed ½ gal. per yd., and in more cases probably use 0.4 to 0.45 gal. per sq. yd. for the treatment. The amount of material depends upon the tightness of the surface. We have found that the smallest quantity of material we can use and get the surface covered gives us the best result. With a small quantity we never have trouble from rippling or waving of the surface, provided the gravel is in proper shape to receive the treatment when it is given, that is, thoroughly bonded and tight, with no pockets of loose

gravel, dust or other material. We also find that surfaces which have received a small quantity of tar can be re-treated for a longer time than surfaces which have been given a heavier treatment. Those which have received the heavier treatments will ripple and get out of shape, say in two or three or four years, while sections receiving a light treatment can be maintained without breaking up for a considerably longer time.

It must be borne in mind that the addition of the bituminous surface treatment to a gravel road does nothing but preserve the surface against disintegration from passing traffic. It does not materially strengthen the road in the sense that is will cause the road to carry heavier loads than the gravel surface itself or the foundation upon which it is laid will sustain. Surface treatment will not supply or take the place of drainage.

Patrol Maintenance of Treated Sections

Our surface treated sections are kept under constant patrol maintenance. We patrol these roads with a light truck and two men and they are assigned sections anywhere from 12 to 18 miles long. Besides watching the bituminous surface and mending any small breaks that may occur—and we have these breaks occasionally—and patching the shoulders, these men also keep the dirt shoulders shaped by dragging, keep the gutters and culverts clear, and do whatever other work is necessary.

We supply about three barrels of bituminous material like that with which the road is treated for each mile of surface. This material is mixed with sand and kept in stock piles. The mixing is usually done by hand and we use about 17 gals. of tar to a cubic yard of sand. In a few instances we have used a small concrete mixer to prepare the tar and sand for patching and we have been able to use as little as 14 gals. to a yard of sand when the mixing is done in a concrete mixer. Patches are made by simply cleaning out the hole, throwing in the mixture of bituminous material and sand and patting it in with a shovel. Any bad breaks on the shoulders are repaired the same way.

The Spring Period

The most of our gravel treated surfaces do not remain intact over the spring period; a good deal of it breaks up. This is due to several causes. An open winter which allows the frost to penetrate deeply into the roadbed and allows traffic to run all winter long, or heavy traffic coming on these surfaces when the frost is leaving and the surfaces are soft will break up and generally disintegrate the surfaces. This really is more or less of an advantage, because it obviates the necessity of breaking up these surfaces and we save just that much expense in getting the surface ready for subsequent treatments.

I have in mind one section of gravel road which was surface treated during the summer of 1920. Most everyone called it a good section of road, in fact many automobilists have referred to it as bituminous macadam, and many of our citizens refer to our surface-treated gravel roads as bituminous macadam roads, especially when they want to tell about a bituminous road the Highway Commission has built which has failed in the winter. The particular section I refer to was so bad during March, 1921, that automobiles could not pass over it, or through it. For four or five miles this piece of road was literally a sea of mud for a period of about three weeks. Of course the surface treatment completely disappeared. We reshaped the road as it dried out and retreated it last spring. It presented a good surface all through the summer and fall until it was covered with snow.

On the other hand, I have in mind one section of surface treated gravel road which is built on a sandy foundation, where the drainage is perfect, that has never broken up during the last eight years. It gets a re-treatment about every other year, maybe 1/6 or 1/7 gal., as the gang goes by, and during the intervening year it does not get treated. This particular section shows evidences of slight ripples. It is on our heaviest traveled line, where the snow leaves earliest in the spring and we have the most severe truck traffic in the State.

We have a good many sections of surface treated gravel roads which do not break up in the spring. The most of these sections get a re-treatment each year. The second year the amount of tar which we have used has been from 3/10 to 1/3 gal. per sq. yd. For the third and fourth years the amount has run as light as ¼ gal., and in some instances 2/10. These surfaces are quite likely, however, after three or four re-treatments, to become ripply enough so as to be uncomfortable to ride over. This condition is due to a combination of reasons. One is that we may have as much as 1½ or 2 ins. of tar penetration which becomes separated from the gravel road itself on account of the passage of heavy loads when the frost is coming out of the roads

and the whole roadbed is more or less soft. Where this tendency exists at all it is always more pronounced where the surface has received successive treatments than where only one or two treatments have been given.

Each year we have to break up more or less of this kind of surface and get the road in shape for new treatment. The method used is about as follows: We take a section of road about 1,000 ft. long; it is broken up either by using a pressure scarifier or a steam roller or by using a heavy blade grader behind a truck or a roller and setting the blade so that it will do more of a plowing operation than a scraping one. The bituminous surface is in this way broken up into chunks anywhere from 2 ins. to 2 or 3 ft. square. We next take a road grader and scrape this whole surface off to the shoulder of the road, then we plane the roadbed below to as true a surface longitudinally and transversely as possible. We then work back a portion of the bituminous bound material from the shoulder, distributing it over the surface. In this distributing operation the bituminous bound gravel is broken up more or less into small chunks. We then leave the road for two or three days for traffic, which materially helps in further breaking up these pieces of bituminous bound gravel, then the road grader is brought on and further working of the surface is given just by pushing the chunks around and pulling in more from the sides. By watching the surface carefully and using the road grader every two or three days we have been able to get the surface back into reasonably smooth condition. It presents more or less of a mottled or mosaic appearance.

Gravel which has been covered with the bituminous material has lost its binding property and it is necessary quite often to add a bit of good binding material here and there to complete the bonding of the surface. This binding material is used sparingly. We do not intend to have enough to leave any appreciable amount of dust to be swept off prior to the new treatment. As soon as we have the surface in shape we plan immediately to give it a new application of tar. We find that one of these surfaces broken up and reshaped as just described is very hard to keep in true contour under traffic and if it is allowed to go, say, two weeks, we may have to break it up and rebond it before the tar surface treatment is given, else it would be so uneven as to be a bad riding road all through the season.

Experience has shown that one of these old tar surfaces can be scarified and broken up much more easily when the temperature is between 60 and 70 degs. F. than during cooler weather. Good warm, sunny weather also materially assists in breaking up the chunks of tarred gravel which are left on the surface of the road.

Gravel Surface Must Be Dry

One thing we have satisfied ourselves upon is the fact that we cannot successfully apply tar surface treatment on a wet road or on a damp road. We have also had the experience of rain falling within two or three hours after tar has been applied and before the tar has taken any set, and with a traffic, say, of 100 to 200 cars per hour this has resulted in making a mushy surface which it is practically impossible to true up and make satisfactory. We have practically come to the conclusion that when this condition prevails we would do better to scrape the new tar surface right off on the shoulder, throw it away, reshape our road and put on a new application of tar. We will spend more money in patching the surface which is laid under these conditions than it would cost to replace the surface, and such surface after patching has never been satisfactory.

Costs

During the last four years our surface treatment work, plus the cost of patrol maintenance, for a season of eight months has averaged to cost $1,000 per mile. We estimate sand to cost us an average of $2 per cu. yd. delivered in piles alongside the road. Tar costs us $0.12 in tank cars delivered on the nearest railroad siding. We figure the cost of applying the tar at $0.02 per gallon. Sanding costs about $0.75 per cu. yd. of sand. Using, say, 4,000 gals. of tar per mile gives us a cost for tar on the roadbed of $560; 50 yds. of sand will cost $100, applying the same $37.50, making the cost of the tar treatment covered with sand $697.50.

The average cost of shaping and getting the surface ready for treatment in the early spring would be about $25 per mile. We use ordinarily a 2-ton truck to draw the road machine. The truck rental would be $10 per day, the driver's pay $3.75 and a helper $3. The rental of the road grader is figured at $2 per day. Gas and oil will run from $5 to $6 a day. This outfit will average to smooth four miles per day. Usually on the first smoothing we make about four round trips per mile. On subsequent smoothings possibly two trips will do; it all depends upon the condition of the road when it

is smoothed and the subsequent condition of rain and settling of the road.

Sweeping

For sweeping we use a mechanical sweeper drawn by a light truck, say a ¾-ton or a 1-ton truck. We usually make four round trips with the sweper, and this outfit will sweep about two miles per day, as we can only run the sweeper about three miles per hour. The expense for sweeping would run about as follows:

Truck rental	$ 5.00
Oil and gas	2.00
Driver	3.75
Helper	3.00
Rental of sweeper	2.00
Making a total of	$15.75

An expense of sweeping two miles of $7.87 per mile.

An expense of sweeping two miles of $7.87 per mile.

The balance of the $1,000 is paid for patrolling the road through the season. The usual patrol gang on bituminous surface treated gravel roads is a patrolman with a 1-ton truck and helper. According to the amount of traffic and the condition of the road, this outfit will cover anywhere from 12 to 18 miles of road. The outfit costs $13.75 per day, made up as follows:

Rental of 1-ton truck	$5.00
Gas and oil	2.00
Patrolman, who drives the truck	3.75
Helper	3.00

These gangs work an average of 200 days per year, so if the patrol section was 13¾ miles long the average cost per mile would be just $200.

Based on the figures given above, this would show a maintenance cost of $930.37 per mile. I have said that on new roads we use ½ gal. of tar per sq. yd. That will increase the cost $140 per mile over the figures already given.

Where it is necessary to scarify or break up the old bituminous surface, we run into a considerably larger expense for preparing the surface than indicated above. I think I have given enough explanation, however, to show that the average cost is very close to $1,000 per mile.

There is one point that I neglected to mention, and that is that quite often in making an original treatment if traffic is running fairly heavy and it will take us six or eight days to treat the section we are working upon, we will slide over the road with a priming coat of the tar material, using 2/10 to 1/4 of a gal. per sq. yd., the quantity depending upon the tightness of the surface. This will hold our surface in perfect condition under traffic for a week or ten days. We immediately apply the balance of the quantity, sand, and finish up the job. We have almost come to the conclusion that it would be good practice to do the priming everywhere on new surfaces. It gives a better penetration of the bituminous material, besides holding the surface in proper contour until the treatment can be completed.

I ought to state before closing that we have many miles of surface treated gravel roads which are carrying a 12-hour traffic, from 7 a. m. to 7 p. m., averaging from 2,300 to 3,500 vehicles per day for a week's time, with a maximum traffic during the 12-hour period of as high as 5,500. This traffic continues for a period of four to five months, from about the twentieth of May until well toward the first of October.

We find it impossible to hold our gravel surfaces in satisfactory condition by ordinary patrol maintenance methods, that is, dragging and patching with gravel, when the traffic exceeds 500 to 600 vehicles per 12-hour day, and the expense of such maintenance runs about $500 per mile.

The material which we use for surface treatment falls within the specification T. C.-1, Tar for cold application, Bulletin No. 691, U. S. Department of Agriculture.

Credit for the most of the developments we have made in surface treatment of gravel roads is due to Mr. A. J. Wiggin, Superintendent of Maintenance of the Maine State Highway Department.

The foregoing matter is from a paper by Mr. Sargent before the recent conference of highway engineers at the University of Michigan, Ann Arbor, Mich.

HIGHWAY MAINTENANCE IN BUREAU COUNTY, ILLINOIS

By C. L. Melcher, County Superintendent of Highways of Bureau County, Court House, Princeton, Ill.

Bureau County is one of the rather large size counties in Northern Illinois, having an area of 881 square miles and a total road system of 1,482.2 miles, with 296 miles of State Aid System. The county has considerable variety as to soil and topography, there being almost any condition in Bureau County that will be met in the State of Illinois. We have some very hilly country that is mostly clay, with some timber covering, and we have the typically rolling prairie and there is also some swamp land, hardpan and blow sand. These conditions are met with on the State Aid and Bond Issue Systems in Bureau County and some of them are difficult to overcome. Probably the heaviest

earth work section on the Chicago-Springfield road is in Bureau County between Spring Valley and Depue. Grades of 7 percent were found necessary by the Division of Highways to overcome the heavy hills in that section .

Previous to Jan. 1, 1921, the county had done the usual amount of grading as done by the several townships, had met the allotments of the State in the construction of about 9½ miles of concrete and brick pavement on the State Aid System and had advanced funds for the construction of a 15d section on the Chicago-Springfield road. No plan for maintenance of earth or gravel roads or the improvement of the State Aid System had ever been presented to the people of the county nor had any such maintenance been done by the county.

In the summer of 1920 we conceived the idea of maintaining and reconstructing the State Aid System outside of the Bond Issue System in Bureau County and for the purpose of carrying on this work for four years, the Board of Supervisors passed resolutions asking for a special tax for this work under authority of Section 27 of the County's Act of the Illinois Statutes. The rate of tax for this work was placed at 60 cts. on each $100 of assessed valuation and was presented for a period of four years with the idea that at the end of that term conditions would be somewhat different and construction and maintenance plans would then be revised for carrying on further work. This tax was calculated to yield about $215,000 per year, or a total of $860,000 in four years.

It was not expected, at that time, to do any extensive improvement on the sections of the State Aid System that were already well surfaced with gravel, but to give speedy relief and improvement on the worst sections by grading, draining and gravelling. The tax was voted with a majority of about 3 to 2 and the Board of Supervisors levied the tax and began to plan for the first year's work.

Changes in the State Aid System

At the same time that the plan was presented for the maintenance and improvement of the State Aid System of the County, a resolution was presented providing for a revision of the State Aid System in order to give a better engineering location and as a consequence better connections between the several towns and communities of the county, especially with the Bond Issue System. The routes were made in such a way as to give the several townships that were not fortunate enough to be on the Bond Issue System a direct and quick connection to that system and also to connect consolidated schools, country churches and community centers.

A county system of highways is a secondary system of roads and should be located and improved in such a way and in such order that the so-called through routes may be of greater service to each county and community. An analogy could be drawn between the Bond Issue System and the State Aid System of the several counties and a double-track main line railroad and its branches. We cannot all live on the double-track line, so we must have branches or feeders to these main lines that are of real service, or, in other words, will handle the local traffic for 365 days of each year. We will then begin to have real "farm-to-market" roads and our highway system will realiy begin to function. People living in townships off the Bond Issue System are going to demand that kind of service.

Bureau County Road Problems Similar to Those of a Greater Part of the Counties of Illinois

We began our work in March of last year by first establishing a patrol system of maintenance on the entire county system. Men were selected who seemed to be able to work by themselves without too much close attention or check on the time they put in on the work. These men were not teamsters but a great many of them were men who had farmed and knew road conditions where they were employed. They have given us, as a whole, very good service and most of them will be employed in 1922. Their experience and training is worth money to us. We employed 27 men on 230 miles of road with the sections having a mileage of from 7 to 11 miles. We have found that the proper size section is about 7½ or 8 miles where there is a fair amount of traffic. On an earth road a patrolman will get behind in maintaining his section when we have a succession of showers at one or two days interval. This is true even in weather when the roads dry very quickly on the morning following the shower. Some patrolmen like to tackle the worst mile first and give that a thorough smoothing before taking the rest. But that system is not correct. They should on an ordinary width of roadway, travel over the entire length of the section on one track and return the same day by widening that track. This will give within a few hours, one smooth path for traffic. The next day

they can cover the other side of the roadway and will probably need an additional day to shape up spots that have dried later or that were badly cut up. An earth road is a wonderful road when it is smooth and the patrol method of maintenance is about the only way you can keep an earth road smooth. The continual working of the surface seems to case-harden the top and it becomes very durable. The ordinary rains and the milder seasons of the year do not affect it greatly if it is properly graded. We have found that our earth roads that were patrolled were fit for use during the summer season a couple of hours after a rain. Even the graded sections seem to shed the water very easily because there was no place for any water to stop and soak up the surface or damage the subgrade. However, an earth road will not stand such a prolonged wet spell as we had last fall. They will simply become so thoroughly saturated that they are of little use.

The patrol system of maintenance is the only reasonable way of keeping a gravel surface in condition for travel. Our old gravel roads when we took them over were very rough and full of holes and stones. We scarified those roads at a cost of from $30 to $50 a mile and the patrolmen raked off the stones and worked the loose gravel into the proper shape. The worst kind of a gravel road can be very effectively cured in this way and put in such condition that there seems to be a new surface. Where gravel is thin, it should have additional material put on at that time. The scarifying should be done to the depth of the deepest hole and all material should be torn loose with a scarifier and then thoroughly worked over with a blade grader. Where old gravel has had surface treatment such as oil, tar or bituminous material, the working with a blade after scarifying will break up the lumps and the road can be reshaped easily. However, after the big blade has done this work a patrolman should finish the job. The continual moving of the materials on top with a patrol grader as traffic in breaking up a portion of that old crust, serves to put the surface in a wonderfully smooth condition. The grader puts the real finish on that job. You will have to remove some teeth from the scarifier in an old oiled gravel road because it is very tough and very hard to break up. The tractor and scarifier have work up to their capacity. To maintain a gravel road properly you need loose material on the top that is moved back and forth with the patrol grader. In other words, the surface cannot be kept smooth until it is, as we say, alive. A gravel surface that packs and leaves no loose material is very hard to patrol because the only way to fill the holes or depressions is to cut loose some of the packed material or scarify the surface. After a rain the material that seems to have been rather sandy or lacking in binder will bind with the old material and form a fresh surface for travel.

We found further, that the two-horse, four-wheeled grader with the 6-ft. blade is the best machine or tool for patrol maintenance. However, there is considerable work on most sections of road that should be done by hand. The patrolman cannot make a good road with just a patrol grader. He will have to exercise some of his muscle. On hilly sections of road the ditches are either cutting or filling and they must be maintained and the water kept from flowing down or across the roadway or from undermining the shoulders. In cuts or on side hills the earth is continually moving into the ditches from the banks and the patrolman must care for his shoulders and clean the ditches before they become clogged or the water damages the roadway. In the heavier maintenance a large blade grader can clean those ditches very cheaply and effectually and also straighten or deepen the outlets.

The quickest way to get any road in a useable condition is to establish a patrol system of maintenance. A patrolman can simply work wonders with almost any road. At the beginning of our work we found that everybody wanted service of the large blade graders but this demand was lessened when a patrolman had been on the work three weeks or a month. In addition to the patrol grader, we furnished our men common slip scrapers and they furnished their own small tools.

Betterment of the County System by the Use of Ordinary Methods

Without doubt, the tool or machine most misused in highway work is the blade grader. The newer type of blade graders are a real road-building machine when you have properly trained operators. Bureau County purchased four tractors and four 12-ft. graders to begin the work of bettering the county road system. Two scarifier attachments were bought for these graders and our most economical and efficient work was done with these machines. The right of way on our roads in Bureau County averages from 50 to 66 ft. in width. With the old style of grading there seemed to be too much right

of way and a great many of the farmers began to move their fences in the road. On some roads there was considerable brush, stumps, trees and telephone poles on the road side of the ditch line. Where we encountered brush, stumps and trees, we used dynamite and the tractor to remove them and then cut our ditches straight through. We have staked our ditch lines at 40 ft. center to center by setting lathe on what might be called permanent ditch lines. The center line was carefully placed as possible with relation to fences and the present right of way as it would be placed for paved road. Then the ditch stakes were set with a transit 20 ft. each side of the center line, making a clear road way after construction with the blade grader of about 30 ft. We graded on county work approximately 70 miles of road and 20 miles on township roads. This was in addition to the scarifying of 70 miles and other maintenance of approximately 40 miles of road. Where the approaches to bridges and culverts were narrow and there were short hills to cut off or bad holes to fill in straightening the alignment, we employed teams to remove the earth longitudinally. The blade then cut the ditches and balanced up the earth work on the entire roadway. Our ditches are from 24 to 36 ins. deep, with occasionally a somewhat greater depth where we wished to raise the grade or have more waterway in the ditch. Some of these old roads were lower than the adjoining fields and that meant moving from 2,000 to 3,000 yds. of earth to the mile with the blade grader. Our road sections were built to give us approximately 6 ins. of crown on the 30-ft. roadway with the 1½ to 1 slope on both sides of the ditch and about 15 ins. width on the bottom of the ditch. This was modified where we worked in sandy sections or on hillsides. We have one piece of swamp land or slough that they said we could not grade. It was below the level of the fields and the soil was yellow and blue clay and just plain mud. We graded that in July and the clay brought up from the ditches has made an almost impervious surface. It seems to bear the weight of traffic better than any other section of road we have and it is cut up less after heavy rains. Our theory is that we have simply brought up material that formed a waterproof coat on the top of the old soil. Similar conditions have been observed in other places where hard pan or muck was uncovered in the ditches and we have found that the mixture of this material with ordinary top soil forms a first-class surface. It is better than either material would be alone.

The 12-ft. blade grader will build a cheaper and better road than any other size. It takes power to pull such a machine with a full load but the same men can operate the tractor and the grader as would be required by smaller outfits with the advantage that they move from two to four times the amount of the material and do it easier. The grading of roads with the old style horse grader is a thing of the past. Six, 8 and 10 ft. blade graders are too light to stand the punishment of continuous work. Our four outfits worked from the twentieth of March to the first of November without a stop except such as conditions imposed upon us. We really carried on the work too long in the latter part of the season, but the demand of the townships kept us going.

In grading an earth road, set stakes with the transit on the permanent ditch line and then the first round of the grader, cut the sod far enough back from the ditch line to clear the back slope of the completed ditch. Cut this sod with a light cut and move it into a line under your new shoulders. Then by successive rounds cut your ditches and move the loose earth on and over the entire roadway. To make the best job your ditch cuts should be made in the manner we speak of as stair-stepping. That is, make the first cut a couple of feet outside of the ditch line, being careful to get the cuts straight and parallel to the line of the new ditch. The second cut for deepening the ditch should be made from 6 to 9 ins. toward the road side of the first cut. The third and following cuts are made in the same manner, spreading each layer of fresh earth over into the roadway and building up the shoulders. When the ditches are deep enough, but on your back sloper and trim the back slope and clean out the bottom of the ditch. It will take two rounds of the grader to clean the ditch properly and cut the back slope. This last material goes upon the shoulders of the road and is spread from the shoulders to the center line of the road. On most of the old roads that had an excessive crown, we have not raised the center of the road. All the earth we have cut out of the ditches and from the back slope has been used in building up the shoulders to that old crowned road and giving the road a 6-in. crown.

When you have completed a mile of road in this manner you will find that

it is very loose. That is, the soil you have cut from the ditches and back slope is more or less like new cultivated soil in a field or like a garden. To finish and keep it smooth under traffic, put on a patrolman immediately. He should continually work that fresh surface under traffic and help fill the minor depressions as they appear and dress up the surface. In fact a patrolman completes the road or changes it from a fresh graded roadway to a finished subgrade.

A few of the people who visited Bureau County last year to see our grading have rather thought that a lighter grader and tractor would answer the purpose almost as well. We believe otherwise, and while the 12-ft. grader seems to be a large machine, it is not one bit too large and I believe that when a tractor is developed to draw a 16-ft. grader, that we will find we can build cheaper roads with the 16-ft. blade than we can with the 12-ft. machine.

About the cost of that work, the team work has amounted on many sections of road to more than the work of the tractors and blade grader, while the blade certainly moves many times the amount of earth in cubic yards. Our blade grader work has cost us, not counting the item of depreciation of equipment, all the way from $100 to $400 per mile. The sections of least expense were in a rather sandy country where we could not cut and did not require a deep ditch, and the heavier cost sections were where bad weather was encountered or conditions such as stumps, trees and heavy grading. It is the amount of earth you move with any machine that counts in the cost of the road. The yardage of earth moved by the blade grader has been estimated at from 1,000 to 3,000 yds. We have found it not necessary in this work to close any roads during construction, but have kept them open and the fills smooth in order to get the benefit of such traffic as we had, to help pack the roadway. In the grading of our county roads, we have cut 23 corners, to a minimum radius of 300 ft. This was done at the same time we did the other work, so the teams and blade could shape up those curves and make them a part of the new road. We have banked the turns at about 1 in. to the foot, and find them to be very fast. Some of our reckless drivers have taken them at upwards of 50 miles an hour. The first corner was rather difficult to buy because people did not think it necessary for safety and thought it gave the people a chance to speed up on the corners, but of late, the township commissioners have been coming to me and talking about some of their corners that people complain of now, as being unsafe. While we have not yet worked out a standard for the connection of the township roads with our county roads, nor township roads with county roads, it would seem that something could be done either to keep the corners clear or to round them to a smaller radius, say probably 100 ft.

The foregoing paper by Mr. Melcher was presented at the recent Superintendents of Highways Convention held at the University of Illinois, Urbana, Ill.

DETOUR PRACTICE OF PENNSYLVANIA STATE HIGHWAY DEPARTMENT

During the last three years the State Highway Department of Pennsylvania has developed a system of marking detours which has eliminated for the most part the criticism which occurred in 1919, when the department embarked on the most extensive road building program launched by any American state. Everything has an infancy—and detour marking in its infant stage was of a crude sort. As developed by the Pennsylvania Highway Department detour signs give the traveler complete information concerning not only large towns, but as to the smaller places reached by local detours.

Standard signboards are used on every detour in Pennsylvania. These are of wood, so built as to protect the signs from the soaking effect of rains. On the upper portion of the board appears the large word "Detour," a direction arrow and the words "State Highway Department." There are three different standards governing the lower portion of the board. One gives information concerning the terminus of the detour, with notations concerning intermediate points, as: "To Lancaster. Via Columbia and Mountville." A second bears the same information, and below it the further direction: "Road Open for Traffic to Salunga." This means, of course, that while the main highway is closed to Lancaster traffic, it is open for traffic going only to Salunga. The third standard contains two-way directions, thus: "To Lancaster, via Columbia," with an arrow pointing in the proper direction, and "To Lebanon, via Cornwall," with a pointing arrow. It is frequently necessary to give directions concerning points in both directions.

The lettering on all detour signs

throughout the state is now uniform. Originally blue crayons, or red, were used, and the names of towns and cities were written on white cards. The weather quickly erased these names. The result was confusion. The department has supplied each of its 15 district offices with standard stencils. With a stencil it is not possible to secure a full letter, so that the offices fill in the open spaces, completing the letters as shown in the standards. The resulting sign can be read at a considerable distance, and they are placed so that at night the beams from headlamps will reach them. It is particularly provided by the department that no sign may be placed where it will be beyond the rays from lamps, and the engineering forces, before erecting signs, cover the roads at night, to be sure the locations are right.

The signs at the beginning of the detour give complete information concerning the terminal points; those within the detour give information concerning the termini, and also local points. The colors used on the entire sign are distinctive, not only in daylight, but under lamp rays. The sign approximates 24 by 36 ins., and is mounted on a post, the height of which depends upon the angle at which the sign is reached by rays from lamps.

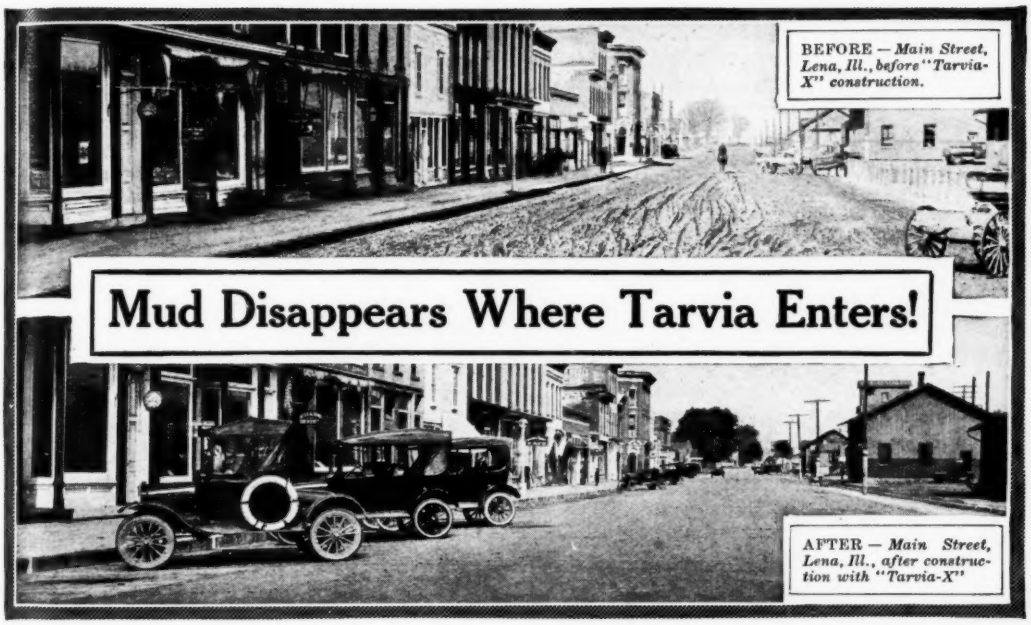
One difficulty encountered by the state's engineers is in keeping detour signs in position. There seem to be at large a great number of vandals who delight in tearing the tin and heavy cardboard signs from the signboards and throwing them away. Instances have been reported where the entire sign, including the post, has been torn down and carried away. In other instances persons with peculiar ideas of humor have reversed signs in such a way as to give directions exactly opposite of correct. While an effort is made to inspect the signs on each detour daily, it is sometimes impossible to do this, and the troubles encountered by travelers who see no signs are directly the result of the work of the vandals or mad wags who are having what they call a "little fun." Some trouble was had for a time with persons who imitated the department's signs for advertising purposes. In an eastern Pennsylvania county a number of roads were placarded at intersections with signs bearing a very large "DETOUR," and the smaller notification that a merchant had a piano sale. The traveler, seeing only the larger word, was far off the road when he discovered his mistake. This lack of discretion on the part of advertisers resulted in an enactment of a law prohibiting the imitation of a State Highway Department sign for any purpose.

At this time there are approximately 200 detours on state highways in Pennsylvania, and approximately half a hundred on county or township roads. In several instances there are very rough detours occasioned by work on city streets which bars entrance to a municipality. Not all detours are under the control of the State Highway Department, by any means. The standardization of detour signs makes it possible for travelers to know whether the detour is occasioned by state work or otherwise.

The State Highway Department is frequently asked why it cannot put its maintenance forces to work on township roads used as detours, so that they will be more travelable. Under the state law this is an impossibility, the department being forbidden so to spend its money. Maintenance of these roads is by the authorities who control them. The department, in the majority of contracts for the last two years, has secured agreements from counties or townships providing for the upkeep and repair of detour roads by these units, but in some instances the agreements have been ignored after actual use of the roads by detour traffic begins. The public, unacquainted with the facts, criticises the Highway Department, which is of course blameless.

One of the worst detours in Pennsylvania since 1919 was that on the Lincoln Highway between Saluvia and Harrisonville, Fulton county. Two side roads were used—one for east-bound and the other for west-bound traffic. Both roads were merely earth trails, and the heavy traffic soon cut them to pieces. Efforts of the department to secure their improvement were fruitless. Complaints were not only numerous, but very loud. However, the detour was removed over a year ago and the memory of its roughness is very faint with those who travel the three-mile concrete section the construction of which occasioned the detour. The inconvenience suffered by travelers during periods of construction is part of the cost of good roads. The topography of Pennsylvania anad the type of highway being constructed make it impractical to build half the road at a time, as is sometimes suggested.

The State Highway Department each week issues bulletins concerning detours removed and inaugurated. These bulletins are sent each daily newspaper for publication, and in addition are posted in


BEFORE — Main Street, Lena, Ill., before "Tarvia-X" construction.
Mud Disappears Where Tarvia Enters!
AFTER — Main Street, Lena, Ill., after construction with "Tarvia-X"

THIS is an era of progress. And progress follows the line of least resistance. It can never reach the community that is marooned for weeks at a time in an ocean of hub-deep mud.

Today the entire nation is aware of these facts—is alive to the need for better roads. From farm and town alike, comes the demand for durable, economical, all-year highways.

The Age of Mud is giving way to the Age of Tarvia. For in the building of good roads Tarvia is playing a leading part. Road officials and taxpayers know from experience that Tarvia roads give the most for the least money.

Economy of first cost, and economy of maintenance brings smooth, dustless, mudless, all-year Tarvia roads within the financial reach of even the most humble community.

Tarvia is a coal-tar preparation for use in building new roads and repairing old ones. It reinforces the road surface and makes it not only mudless and dustless but waterproof, frost-proof and automobile-proof. Where existing macadam or gravel can be used as a base the cost of a traffic-proof Tarvia top is extremely low.

Illustrated booklets descriptive of the different methods of applying Tarvia, will be sent free on request.

Tarvia
For Road Construction Repair and Maintenance

New York Chicago Philadelphia Boston
Detroit New Orleans Birmingham Kansas City
Peoria Atlanta Duluth Milwaukee
Youngstown Toledo Columbus Richmond
Baltimore Omaha Jacksonville Houston

The Barrett Company

St. Louis Cleveland Cincinnati Pittsburgh
Minneapolis Dallas Syracuse Salt Lake City
Bangor Washington Johnstown Lebanon
Latrobe Bethlehem Elizabeth Buffalo
Denver San Francisco

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

930 garages, motor club headquarters, Chambers of Commerce and other places where the traveling public may secure information.

TULSA TO HAVE LARGEST STORM SEWER IN SOUTHWEST

By Charles Schultz, City Engineer, Tulsa, Oklahoma

There will be constructed soon, in the City of Tulsa, Okla., what is probably the largest storm sewer in the Southwest. This will be a relief sewer to take care of the storm water draining from an area of over 2,000 acres, which will carry 3,500 cu. ft. per second that is not now being handled by the storm sewer which was constructed several years ago.

After the old storm sewer was constructed, the whole basin was covered by valuable residences anda municipal improvements of all kinds, which shortened the time of concentration of storm water to approximately 30 minutes, and caused a condition of overflow that has caused the property owners many thousands of dollars in water damages and property depreciation. Early in this year a bond issue of $900,000 was voted to remedy this condition and preliminary work was started on the design of this structure.

When the writer took charge, as City Engineer, a large amount of the data had been collected and several preliminary lines of location run. Early this summer Mr. W. W. Horner, of St. Louis, was retained as consulting engineer and suggested the feasibility of building this sewer in tunnel cut. New lines were run looking to this method of construction and estimates prepared which show that the tunnel cut is the desirable method of constructing this improvement, when the inconvenience to the public and the damage to private property is taken into consideration.

Core borings are now being made which show that the covering above the sewer will be part sandstone and part shale, considered sufficiently stable to support the roof during construction. The work will probably be carried on from two central shafts, and perhaps one end, as it is very essential that this project be completed at an early date.

The length of the entire project is approximately one mile. The run-off is being calculated by the rational method. An interesting feature in this computation was presented by the fact that no rainfall records showing the rate of precipitation were available for more than five years, so that it became necessary to use the rates of rainfall from neighboring cities where longer periods have been covered.

The arch section is being designed by the elastic theory, the work being in the immediate charge of Mr. Geo. E. Wakefield, acting with the writer.

OCCUPATIONAL INDEX OF ENGINEERING POSITIONS

The procedure in gathering, compiling and studying data relating to the engineering profession for the purpose of preparing an occupational index of engineering positions has been outlined in the first report of the Committee on the Classification of Engineering Positions recently appointed by the American Association of Engineers. This committee consists of A. B. McDaniel, educational specialist in the War Department, chairman; C. R. Mann, Civilian Advisory Board, General Staff, War Department; Prof. C. J. Tilden, Yale University; J. R. Randall, president, Rochester Mechanics Institute, and W. C. Bolin, pilot engineer, B. & O. R. R., Baltimore, Md. E. O. Griffenhagen, J. L. Jacobs, of Chicago, and Prof. H. H. Stock, of the University of Illinois, are advisory members of the committee.

The program of the committee includes: 1. The preparation of sample specifications to send out with occupational study sheets. 2. Preparation of blank occupational study sheets. 3. Sending out of occupational study sheets and sample specifications to at least 50 practicing engineers in each position to be studied, with the request that the information indicated by the study sheet be promptly furnished. 4. The compilation of data received. 5. The preparation of preliminary specifications for publication and criticism by members of the profession. 6. A study of the criticisms received and preparation of provisions to complete such specifications.

The field of highway engineering has been selected for the first study by this committee. In this field Prof. C. J. Tilden, during the past summer, while engaged as consulting expert of the U. S. Bureau of Public Roads, has obtained a large amount of valuable data relating to highway engineering positions.

The engineering occupational index should be of value in employment organizations in the selection and allocation of engineers, to licensing boards, civil service commissions, and similar organizations in the allocation of engineers, and to individual engineers.

WATER WORKS SECTION

LAYING 186 FT. OF 48-IN. CAST IRON PIPE PER DAY FOR CHICAGO GAS CO.

(Editor's Note: The largest gas main in Chicago, which is surpassed in size by only two or three mains in the world, is now being laid. The main is 48 ins. in diameter, of cast iron bell and spigot pipe, and it is 4½ miles long. It will be adequate in size to serve a large section of the city, on the southwest side, for many years to come. The work has been of unusual interest to engineers and contractors. It has progressed practically without interruption at an average rate of 186 ft. of completed main per day. The Austin trenching machine has maintained a daily average of 204 ft. with a maximum record of 408 ft. The methods employed on this job are here described from information taken from the Peoples Gas Club News, the journal of the Peoples Gas Light and Coke Co. of Chicago, the Company owning the main. The rate of progress maintained establishes a new record on 48-in. pipe line construction for both gas and water utilities.)

Preliminary Work Important

The grade of the southwest side of Chicago rolls gently to the north and all drainage flows to the Drainage Canal. It was decided that an easy grade be given the 48-in. main to the north and that it follow the natural contour of the ground. Two feet of cover was considered sufficient and by grading the line to the north, no drips would be necessary as the line

NO. O AUSTIN TRENCHER, WITH SUPPLEMENTARY WIDENER, DIGGING 4½ MILES OF 7x7 FT. TRENCH FOR 48 IN. GAS MAIN FOR PEOPLES GAS LIGHT AND COKE CO. OF CHICAGO.

would drain into the tunnel shaft at 39th street.

All underground work was taken care of in advance, arrangements being made with the city waterworks department to lower their mains deep enough to allow the 48-in. main to pass over them. Telephone conduits and high voltage wires were moved out of the path.

An accurate survey was made of Hamlin Ave., along the route of the main and a profile map made showing obstructions. The proposed line was laid out on this profile map and the grade established. Test holes were dug at each street intersection so that an accurate knowledge of the obstructions would be available and on record.

Contract Work Big Item

The general contract for the construction of this main was let to Nash Bros., Chicago. The contractor digs the trench, braces it, places the pipe in the ditch, maintains the trench while the pipe is being caulked, backfills after the pipe is tested and returns the street to its original condition. The Gas Company caulks and tests the pipe. The contract for hauling and placing the pipe along the proposed route was let separately to the W. J. Newman Co., Chicago. The contractor moved his equipment, May 10, to 71st and Hamlin Ave., and the work was started digging the trench May 15.

Digging the Trench

Because the south end of the job was at the highest elevation, and the territory at the north end near the Drainage Canal was open country, having a gumbo soil, very soggy in the spring of the year, it was decided to start at the south end.

Nash Bros. sublet the excavating of the trench to G. T. Thorne of Oshkosh, Wis., who used the large Austin Excavator shown in the accompanying illustrations. This excavator digs the trench, which averages 7 ft. x 7 ft., with ease. A record of 408 ft. dug, and pipe laid has been made, on one day, and since the actual work started an average of 204 ft. per day was made up to August 1. Figuring the expansion of the dirt from the trench, the excavation is running 2 cu. yds. per lineal ft.

An interesting feature is the method of digging the sides of the bellholes as the excavator is working. Due to the digging being done on an incline, bell-holes were measured ahead and men with bars and shovels placed on each side to cut out the bell-holes. The dirt is thrown down on the buckets and carried out of the ditch, proving a great labor saver.

Bracing the Ditch

The pipe is placed in as soon as the ditch is dug, the excavator keeping a few lengths ahead of the pipe-laying. The soil is a clay gumbo and in dry weather stands up remarkably well.

A stretch of dry weather, 43 days without rain, since the job began enabled the work to be carried on very rapidly and to date only single pipe braces have been necessary at each pipe. One of the illustrations herewith shows these bracing conditions.

Placing Pipe In Ditch

For handling the pipe the contractor installed a 10-ton gasoline crane mounted on caterpillar traction. In order to lower the pipe slowly in the ditch and to assist in lining it straight, the single line on the hoist drum was reduced by means of a double set of blocks so that 1 ft. on the drum was reduced to a 2½ in. drop at the pipe.

The traction crane follows closely behind the excavator and it takes six minutes to lift the 48-in. pipe from the bank, place it in the trench, and drive it home.

Laying the Pipe to Grade

Extreme care is taken with the laying of the pipe. Each pipe weighs approximately four tons and it was decided that the trench should be dug to grade, the blocking laid so that the top of the 4-in. blocking would be on grade, which would make the whole pipe, with the exception of the bell-hole rest on the original, undisturbed bottom of the trench.

Constant engineering supervision carries out this plan. Levels are taken on the ditch as the excavator is working, on the blocking before the pipe is laid and on the pipe line after laying for a permanent record.

Digging Bell-Holes and Caulking

Our Company maintains its machinery for caulking and does this work with its own forces.

Immediately the pipe is placed in the trench, the bell-holes are dug in preparation for the caulkers. At no time during the progress of the work so far have the caulkers been more than 25 joints behind the last pipe laid.

The joints are 5 ins. deep and are caulked with 3-in. wool yarn and 2-in. lead wool. Caulking is done by pneumatic hammers and two men work to each joint. It requires approximately 8 lbs. of wool yarn and 126 lbs. of lead wool per joint. Two men average 2 joints per day; 127,500 lbs. of lead wool and 8,160 lbs. of yarn have been used so far on this job.

Compressed air is supplied by 3 Ingersoll-Rand Portable Compressors, capable of supplying a maximum of 210 cu. ft. per min. each at 100 lbs. pressure. A header line runs along the trench and two compressors work on the line. At times as high as 14 sets of caulkers, 26 hammers have worked from this header line.

A unique arrangement of the compressors and header line makes a very efficient layout. The header line is run 2 city blocks ahead of where the caulkers are working and by aid of the extra compressor, 2 compressors are always on the line when one is being moved ahead.

This means that the caulkers are never held up waiting for air while the header line is being moved ahead or the compressors being moved into a new position.

Pumping Surface Water

As precautionary measures against drainage surface water it was decided to have on the job 3 Schramm pumps having a capacity of 50 gals. per min. each. A header line was laid along the top of the trench and 12 ft. lengths of hose connected by unions to this header line and lowered into each bell-hole where there was water. This method proved very satisfactory where water was encountered.

Testing Four-Ton Pipe

The progress of the work is so arranged that the digging and laying of the pipe ends Saturday noon. All uncompleted joints are finished up Saturday afternoon and Sunday if necessary.

The 48-in. plug is put in the last pipe by means of the traction crane. When the last joint has been caulked, the 3 compressors are hooked up to the line and it has been found possible to secure 15 lbs. pressure in the line inside of 8 hours.

The tests have been cumulative up to the present time, testing each week's work in addition to the work that has been finished previously. Up to August 1 a length of pipe from 71st St., to 52nd St., on Hamlin Ave., a distance of 12,500 ft., has been successfully tested.

Backfilling With a Fire Hose

The contractor is backfilling with an Austin Backfiller and puddling the dirt by means of a fire hose connected to fireplugs at street intersections.

Excess dirt, which runs to nearly ¾ cu. yd, per lin. ft. of ditch, is being loaded by a clam-shell crane on traction wheels, into motor dump trucks and hauled away from the job to be wasted.

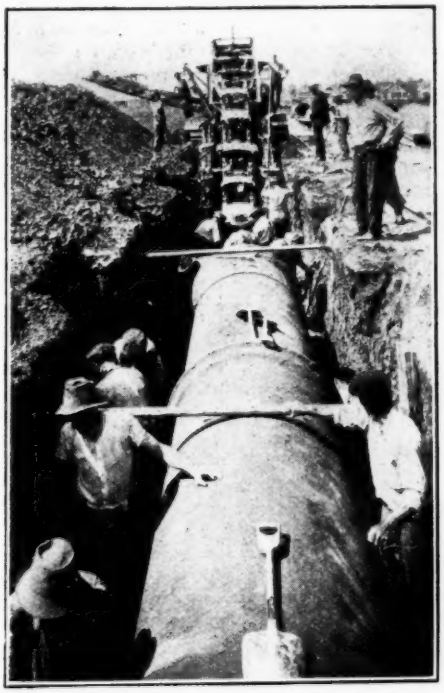
Underground Work

The route of the 48-in. main passes through some of the main water lines of the city of Chicago. At 65th St., it was necessary to lower the 30-in. water main supplying the large Clearing Manufacturing District. This main had to be cut out and lowered 8 ft.

Progress and Completion

The average of 186 ft. per day since the work started is a record for the laying of 48-in. main whether it is gas main or water main.

The Company is determined to have this main completed before the working season of 1922 ends. If the present rate of progress is maintained, the whole line should be laid and gas turned in it by November 1.



DIGGING TRENCH AND LAYING 48 IN. CAST IRON GAS MAIN IN CHICAGO.

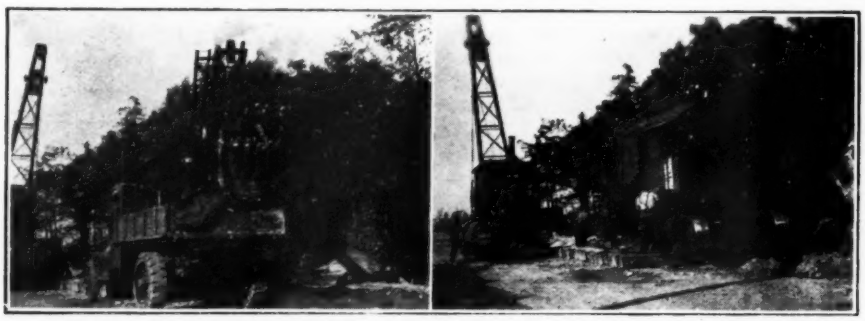
The laying of this 48-in. gas main is being done under the direction of John H. Eustace, chief operating engineer. W. G. Rudd, assistant operating engineer, is in charge of the engineering details. Actual supervision and construction is carried on by the Department of Streets, C. L. Day, general superintendent, through John Ginley, assistant general superintendent, and F. S. Carnes, superintendent South Division.

LAYING 36 AND 48-in. WATER MAINS IN STONY GROUND AT NEW BEDFORD, MASS.

By W. R. Conard, of Conard & Buzby, Consulting Engineers, Savings Institution Bldg., Burlington, N. J.

In arranging for the installation of some large sized water mains the City of New Bedford, Mass., figured that to facilitate the trench work and reduce the laying cost they could use some form of digging machine and after observing the work of the several types of machines used for this purpose decided that the steam shovel would be the most efficient inasmuch as a large proportion of the digging would be through soil having numerous boulders of large size which could be handled with a shovel.

Accordingly a Bucyrus steam shovel, self-propelled, was purchased, and some 6,765 ft. of 36-in. pipe was laid. Following this, plans were made for putting in about 3½ miles of 48 in. pipe line, slightly over 1 mile of which was to go in along a main traveled highway, and the balance along a private right of way belonging to the city.



VIEWS OF HEAVY WATER PIPE LINE CONSTRUCTION AT NEW BEDFORD, MASS.

Bucyrus Steam Shovel is Shown Dumping to Motor Truck Body Direct. Bucyrus Steam Crane Used in Handling Pipe and Other Purposes on the Job.

This private right of way is about 8 miles long, extending from the pumping station to a large storage and distributing reservoir along which there is already in place a 48-in. steel main, and also a private line of standard guage railroad for about 4 miles, extending from the New York, New Haven and Hartford Railroad to the pumping station, and which is used by the city for transporting coal and other supplies.

That part of the new main which is along the highway starts at about the half-way point between the pumping station and the N. Y. N. H. and H. main line, and it was decided to switch the cars to this half-way point, unload them, and distribute by truck along the highway, the balance of the distance from the highway to the pumping station it was decided to switch the cars in and try and distribute direct from the cars along the private right of way.

This brought up the question of unloading the pipe, and at first it was planned to use a platform derrick at the half-way point, store there and distribute along the highway and then perhaps move the derrick in another point along the railroad for unloading and possibly distribute, if necessary, by truck along the private right of way. After considering the matter more carefully the writer recommended that a portable crane be procured so that there would be no necessity for trucking along the private right of way at least, and also because the crane when not unloading pipe could be put to use putting the pipe in the trench, and handling other materials along the line. This appearing the logical thing to do, another Bucyrus machine was purchased, this time a steam crane, with digging lines and a ¾-yd. clam-shell bucket; the traction on this crane is the continuous type of tread, known generally as caterpillar traction.

Work was started in July, 1921, and continued through the rest of the construction season, the steam shovel continuing to prove its efficiency for this class of work, at times taking out boulders of over a cubic yard in area, and averaging around 100 feet of 6x8 ft. trench per day, at an operating cost of around $38 per day. Also the wisdom of the purchase of the crane was soon proven for not only did it unload the pipe from the cars at the half-way point, but also unloaded and distributed them along the highway, and during the intervals it was used to put in the pipe in the trench, to place backfiill

with the clam shell and at odd times when wanted acted as an auxiliary to the steam shovel. In fact so many uses were found for it that during part of the time a tripod derrick, steam operated, was hired and used at the half-way point to unload the cars there, leaving the mobile apparatus free to make itself useful where most needed; the operating cost of this derrick averages $38 per day, which, of course, is spread over the entire operation.

In laying the pipe all of the trench which the steam shovel would make during the day was filled with pipe in about half the afternoon and by using square plaited hemp, which requires practically no caulking, and Leadite, which requires no caulking at all, all joints were made, and each night brought the pipe laying up to the end of the trench opened, with the backfilling to be done the following morning. The earth as excavated was landed in trucks which dumped into the trench to be backfilled a short distance behind. By this means an average of 72 ft. of pipe was laid per day from July to November 20th for that part of the line along the highway, the costs being $15.09 per foot for the pipe and specials f. o. b. cars Braleys Station on N. Y., N. H. and H. R. R., and for the unloading, hauling, trench work, laying, etc., complete, $11.49, or a total of $26.58 per foot furnished and laid.

The above can be considered a fair average as the going while not easy was not particularly difficult, and would, I believe, be representative of general conditions.

Mr. Stephen H. Taylor is Superintendent of the New Bedford Water Department, and the writer acted as consultant for the 48-in. line construction.

PULVERIZED FUEL FOR CAHOKIA STATION OF UNION ELECTRIC LIGHT AND POWER CO.

(Editor's Note.—Recent rapid developments in pulverized fuel equipment, and in the application of pulverized fuel, brings this type of fuel to a point of equality, at least, with solid fuels and automatic stokers. In fact, many engineers will even now be inclined to give preference, under certain conditions, to pulverized fuel. The following timely account of an important pulverized fuel installation is reprinted here from the September issue of the magazine, "Combustion.")

Almost directly opposite the center of St. Louis, on the Illinois side of the Mississippi River, will be built the great Cahokia Station of the Union Electric Light and Power Company. Besides being the last word, to date, in economical power production, the new station will be notable for several things which will give it a deep interest to all who are interested in the development of central stations as a source of power for the country's utilities, its industries and its transportation.

A central station of the magnitude of this one and one upon which so much scientific and practical care has been expended in its planning would have attracted a great deal of attention under any circumstances. The outstanding novelty in this plant, however, is that the source of its power is to come through pulverized fuel, rather than the means usually employed in firing the boilers which furnish steam to the large steam turbines.

For several months this central station has been planned by the engineers and constructors, McClellan & Junkersfeld, who have been determined that they would produce at this point, which is so particularly auspicious for an economical station, what would be a model station of its sort and one which would produce power with uniformity and certainty at a minimum of cost.

The engineers had before them the proposition of a sufficiency for many years of a rather poor grade Illinois coal, known as Bellville. This was available alongside the station at the low price of, probably, $2.50 per ton. The average analysis of this coal showed that it contained 10,000 B.t.u. (as received), 12 per cent moisture, 16 per cent ash and 5 per cent sulphur. The haulage would be about 20 miles from the mines, and the position of the new plant in Illinois would do away with switching and bridge charges. The coal would be used as purchased most advantageously from the mines during all seasons and under all mining conditions. It would naturally often possess various and many impurities, and might run anywhere from lumps to mine sweepings.

With this general proposition before them, the engineers began a series of tests and investigations, the like of which has probably never been equaled, as the preliminaries to the construction of a power plant. Besides all the data that could be collected and all the reports of established tests that could be learned of, independent investigations were set on foot at Cleveland, Chicago, Racine, Milwaukee and other places where opportunities for gaining knowledge from actual operations

were available. The figures gained in these tests were adjusted to a common denominator for the purpose of a proper and dependable comparison of the results. This adjustment included exit flue gas temperatures, auxiliary steam or electric power, and all other factors that were not common to each of the tests compared. Of course, these tests naturally centered around stokers and pulverized fuel. At this time only one basic fact regarding the results of these tests will be given out by the engineers and the company which is building the plant. This fact is embodied in the conclusion that pulverized fuel was determined upon as the power-giving source for the Cahokia Station.

Speaking of the general results which have caused this decision to be made, and which caused a contract to be signed with the Combustion Engineering Corporation for the installation of the Lopulco Systems in the first section of the new plant, Mr. Junkersfeld said that there were several reasons in addition to better fuel economy, some of which could be easily expressed in dollars and cents, and others which could not be so expressed, which led to the determination to use pulverized fuel.

In the dollars and cents column, as the general results of the investigation by his firm show, Mr. Junkersfeld declares should be placed first a saving in fuel by the new method above that obtainable with stokers; second, that there would be a net saving, under the Cahokia conditions, which would come through maintenance, stand-by and pick-up losses, ash removal, and operating pay roll.

Under the head of those things which cannot be easily expressed in figures the engineer spoke of the dependability of pulverized fuel, which he believed was just as good as that of stokers. The question of the quality of fuel was evidently a very important factor. It was obvious that the quality of the coal received was likely to be varied, especially as to its content and form. The satisfactory use of this non-uniform fuel means a great deal. There was a chance that it would at times become very low grade, even lower than the general run as indicated in the analyses. This was a factor which was particularly advantageous to the choice of pulverized fuel instead of stokers.

Another factor which seemed to be regarded as of great importance was that all the coal that passed through the pulverizing mills and entered the furnaces would mean heat and power, while on the other hand, such a drop in quality would be a serious factor in the performance with stokers.

Evidently the engineer also considered seriously the pronounced ability of the pulverized fuel furnace to pick up load beyond anything that the stoker fired furnace would do as ordinarily operated under average conditions. He regarded pulverized fuel in this way to be similar to oil or gas and to have their advantages. He spoke of the recent improvements that had been made in pulverized fuel apparatus and said that they all tended towards greater simplicity and ease of operation, and that this feature also made this method of burning such an important matter in the combustion world.

Apparently when pulverized fuel first presented itself for the attention of engineers, the complicated methods that were then deemed necessary in its preparation and burning did much to hold back its progress. The additional buildings or additional space which were once necessary for the complicated apparatus used in the preparation of this fuel are no longer necessary.

The whole of the pulverizing, conveying and burning of the fuel in the Cahokia Station is to be done within the same walls required by the boilers and in comparatively small space. In fact, Mr. Junkersfeld sums up the situation by saying that pulverized fuel was economical in first cost, economical in maintenance and economical in the use of fuel—so much so that these advantages made the use of pulverized fuel inevitable in the Cahokia plant.

The construction of the Cahokia plant of the Union Electric Light and Power Co. is the result of the natural growth and improvement of the city of St. Louis, which it is to help supply with power and light. It is being built to take that portion of the load over and above that supplied by the Keokuk Dam and that supplied by the present Ashley Street Station of this company. The Cahokia Station is planned to deliver ultimately 240,000 k.w., which will make it one of the great central power stations in the world. That portion of it, however, which is to be built at this time and which is to be completed by September, 1923, is one-quarter of the plant eventually to be erected and will produce 60,000 k.w.

So far as the details of this great station are concerned, the company and the engineers are not prepared to make any extensive announcement at this time. The boilers are to be Babcock & Wilcox, 20

tubes high and 38 tubes wide. There are to be no economizers, as the low price of the coal does not warrant their use. The boilers are designed for 350 lbs. pressure, with the delivery at the throttle 300 lbs. Superheaters will bring the steam up to the total of 690 degs. F. The furnace volume is to be quite large, with natural draft, and a system of water screens at both the bottoms and backs of the furnaces. The turbo-generators will be 30,000 k.w. each, one being built by the General Electric Co. and the other by the Westinghouse Electric and Manufacturing Co. The condensing equipment and all the plant auxiliaries will be motor driven. The feed water for boilers is to be heated by bleeding the main turbines. The heat balance is to be maintained by varying the load on the house turbines.

The power house itself is to be built of brick and steel. The section that will be completed in September, 1923, will be about 170 ft. long, while the whole plant when finished will be about 650 ft. long. The condensing equipment will be located in pits, two equipments in each pit, in order to operate under the 40-ft. difference in the high and low water of the Mississippi River. The entire structure will rest upon cast concrete piles, for the plant is located on very low ground between the levee and the river, parallel and adjacent to the river. This will permit of the shortest possible intake tunnel. Just at this time the concrete piles are being cast, active work is under way and it will continue until the first section of the power house is finally complete a year from now.

"Approaching a question of this sort, as we did," said Mr. Junkersfeld, "we naturally had to be judicial and unprejudiced, but nevertheless we had more confidence in stokers and had been dealing with them for years. The prejudice, as far as there was such, was in favor of stokers rather than pulverized fuel. In other words, the burden of proof was on the newer form of burning coal to prove its case." Perhaps this makes the result, which is to use pulverized fuel at the Cahokia Station, the more pronounced and the more important.

COST ACCOUNTING FOR PRACTICING ENGINEERS

By Arthur L. Mullergren, Consulting Engineer, 512 Gumbel Bldg., Kansas City, Mo.

Why are cost accounting and proper bookkeeping records necessary for the practicing engineer in the conduct of his business? This is a question that is, no doubt, in the minds of a great many of the practicing engineers.

Engineering is a science, a profession and a business. Until very recent years engineering was looked upon as a purely professional occupation and the practitioners gave no thought to the possibilities of the business methods involved. In former days the practicing and consulting engineer simply surrounded himself with a few draftsmen and a stenographer or two and handled only such engineering problems as came under his own particular line of training and endeavor. Furthermore, the engagements were largely unsolicited.

As a science, engineering has made very marked and rapid progress in, we might say, the past 30 years. The practicing specialists in each of the branches of the science as were recognized at that time, i. e., civil, electrical, mechanical and mining, handled individually their respective problems. If a project involved a knowledge of two or more of the branches of the science, several independent practitioners were engaged to carry out the particular work in which they specialized, and the entire work was co-ordinated by a business executive who probably had little or no knowledge of engineering.

As the science advanced and there appeared a demand for organized groups of specialists capable of taking entire charge of a project, the engineering firms and organizations came into being. Where formerly there were about 6 branches or subdivisions of the science, there are today at least 25, and on some of the large projects each branch of the science requires a skilled specialist, and in a great many cases all of the branches of the science are involved in the execution of the work. The Panama Canal, for instance, involved every known branch of the science in its design and construction.

Slow Advance of Engineering as a Business

While engineering as a science has advanced rapidly, as a business it has not. The engineer of the old school was given a thorough training in the fundamentals of engineering, but little or no training whatsoever in the fundamentals of business. As a result, he did not know how to use business methods in the conduct of his professional business. I repeat, engineering is a business as well as a science. In the very last few years it has been taught that business is a science.

To make a success of the engineering business, business methods must be employed. The prime object of any business

is to make a profit. How are the true profits determined in the operation of a business? From the records of the operations. Suppose there were no records kept, yet the owner of the business always managed to have a few dollars left after paying his expenses, which we will say also included his personal liivng expenses. Was a profit really made in the business? That would depend upon whether or not the owner was gradually consuming his previously accumulated capital unknowingly. His capital may have been money, goods or tools. If he is a practicing engineer, thoroughly trained in the science, with little or no money to start, you may say he has no capital. Nevertheless, he has, and the amount depends upon his knowledge and experience. Therefore, if this training and experience is not capitalized and put upon its maximum earning basis, the engineer is losing money.

Cost Accounting Essential in Engineering Practice

In order properly to determine his true earnings, the engineer must keep an accurate account of his operations in the same manner that any other business man keeps a record. There may be a difference in the kind of records, but the fundamental principles will remain the same. Cost accounting in the practice of engineering is as essential as in the industrial line. In order to keep properly accurate cost records of the various projects handled, a proper system of books must be used. The large engineering organizations of today that handle both engineering and construction keep such records, but the independent practicing engineer and the average consulting engineering organization maintain few, if any, records of their operations. Therefore, they are not able to determine whether or not the business is on its maximum earning basis.

Choice of System

The proper system to be used for any engineering business will depend upon the kind and size of organization and the volume of work handled. The larger the organization and volume of business, the more elaborate should be the detail of accounts. The records installed should be neither burdensome nor expensive to maintain, but in keeping with the business in hand and so established that the system can be expanded as the organization and business grow. The fundamental system should, therefore, be established with care. As the average engineer is not very well versed in accounting practices, he should at the start engage a certified or public accountant to establish the system. The accountant should be fully advised as to the character and extent of the business conducted at the time and the ultimate scope and possible extent. This information will enable the accountant to open a system to fit the present needs and one that can be expanded as the business warrants. In establishing the system of records the engineer should bear in mind that his activities broaden with time, so that his present activities are not altogether indicative of the future scope and possibilities.

A System Described

I am giving herewith a system that has been in use in our organization for a number of years, and as it seems to fit the needs of the engineer and is capable of expansion, it may be of some benefit to the practicing engineer. The basic records consist of the following: Cash Book, Check Record, Journal, Voucher Record, General Ledger, and Project Record.

For a smaller volume of business, all of the above records can be combined under one cover if the loose leaf record sheets are used. The loose leaf system is probably the most adaptable for an expanding business and offers the advantage of combining several or all records under one cover when only a small volume of business is handled. As the business expands, the records can easily be separated and separate covers provided for each one.

The system I am explaining embodies the use of vouchers and the voucher system is recommended. This system enables the making and keeping of an accurate distribution of all expenses and keeps a permanent record of the transaction, as well as the original invoices.

The voucher should be of such form that it can be folded into a convenient size when the original receipts are attached to it. The face of the voucher should show the payee, the voucher number, number of check by which paid, and the distribution of the charges covered by the invoice. The vouchers should be numbered consecutively and filed in numerical order. They are listed in the voucher record in numerical order, which record also shows the total amount of the voucher and the date when paid. A separate card index system is used for listing the vouchers by names of the payee, so that any voucher can be readily located.

The cash book shows the dates of all cash received, the amount, by whom paid,

and the date of deposit in the bank. The journal needs no particular explanation, but it is used in adjusting accounts and making correcting entries. The check record provides space for the recording of all checks in numerical order, the date of issuance, check number, payee and account or voucher number to which charged.

The general ledger consists of the asset and liability accounts. For the average engineering business the asset accounts would consist of the following: Accounts Receivable, Notes Receivable, Bank Statement, Petty Cash, Furniture and Fixtures, Tools and Instruments, Library, and Investments.

The liability accounts would consist of the following: Accounts Payable General, Accounts Payable Employees, and Notes Payable.

The remaining accounts would be the capital stock, or present worth, surplus, income and expenses.

The income account should be divided into "fees" and "miscellaneous," as it is advisable to keep the moneys received for miscellaneous purposes separate from the fees for professional services. The expense account should be subdivided and the extent of the subdivision will depend largely on the size of the organization. The following classification of expense account will probably serve adequately for a general engineering practice: Project Expenses; General Expense; Office Expense; Printing, Stationery and Supplies; Office Rent; Telephone and Telegraph; Taxes and Insurance; Legal Expense; Organization Dues and Periodicals; Interest Paid; Development and Advertising; and General Salaries.

The project expense would include all expenses directly chargeable to the various projects being handled, such as the resident engineers' salaries, traveling and hotel expenses for the project, blue printing supplies and time of office principals and assistants actually engaged on the particular project. The project expenses, in other words, represent the total direct expenses incurred for handling the particular project. Each project will have a separate account, so that the actual cost of handling the project can be readily determined. The remaining expense accounts are the general expenses and are properly termed the overhead expenses. At the end of each month the overhead expenses should be prorated to the various projects, according to the size and importance of the project. The total direct and overhead expenses will, therefore, represent the actual charge to each project, and the difference between this amount and the total fee received will represent the profit on the work. The project expenses can be kept in a separate loose leaf book in alphabetical order, and the sum of these project expenses would represent the total project expense as shown in the general ledger.

In order to keep an accurate cost record for each project, all assistants as well as principals should keep an accurate distribution of the time engaged on any particular job. Also, all expenses incurred, such as traveling, hotel, etc., should be filed in the form of an expense account at the end of each month, showing the distribution of the expenses to each job. This expense account and distribution of time can then be readily charged to each project.

The purpose of this discussion is to show the necessity and advantages of proper bookkeeping systems and cost accounting records for engineers, and the brief outline of the kind of a system is given merely to show that it is not an expensive nor burdensome matter to maintain proper records. It is firmly believed that if the practicing engineers kept such records in the proper manner and ascertained the true cost for handling particular classes of work, that more adequate fees would be received in a great many cases. The small fees that are received in a great many instances are due to the lack of knowledge of what it really costs to perform the services contracted for. It is, therefore, hoped that the practicing engineers will systematize their business and keep such accounts and endeavor to conduct their business along business lines, and if this is done the engineering profession in general will benefit, as adequate fees will be charged. No one desires to handle any particular class of business at a loss, and the only way to determine whether or not he is operating at a loss is to keep an accurate record of the cost of his operations.

The foregoing paper by Mr. Mullergren was presented at the Conference of Practicing Engineers recently held under the auspices of the American Association of Engineers.

UTILITY OWNERS FAVOR CONTINUATION OF STATE REGULATION

(Editor's Note.—Fifty thousand Indiana people owning stock in the public utility corporations in the State are being asked by the Indiana Public Utility Association, in a letter recently made public, to rally to the support of state regulation of public utilities, which is now under assault by vote-seeking politicians.)

"We are making this appeal for two reasons," said Charles L. Henry, president of the association. "We believe that the future stability of the industry depends on continued regulation by the state, and we feel that the safety of investments made by Indiana people depends upon regulation. Thousands of Indiana men and women have loaned money to the utility industry because under state regulation they felt sure the industry would be permitted to earn a sufficient return to pay them reasonable interest on their money. They are therefore concerned with any attack made upon the public service commission form of utility regulation."

Benefits Set out

The letter to investors of the utility industry appeals for their co-operation in educational work to show the benefits and importance of state regulation. It sets out the following arguments:

"(1) The repeal of the commission law would be harmful to you as an investor. Your securities would decrease in value the minute state regulation, by which they are controlled and established, is abolished.

"(2) State control prevents 'blue sky' operation in utility stocks, which have become first-class investments because they are issued on the authority of the state.

"(3) The average utility rate in Indiana is the lowest of 36 states having commissions.

"(4) State regulation costs the taxpayer little. The present commission the past year has collected in fees within a few thousand dollars of its expenditures.

"(5) If the commission is abolished city councils will not be equipped to make proper valuations on which a reasonable return may be provided for the security of the investor and the public. No utility can live without a fair and just return and no community can progress without well managed, amply financed and fairly regulated public utilities.

"(6) City councils would not be authorized to make rates for service outside the corporate limits. The public service commission is absolutely necessary to residents of agricultural districts. The commission alone can fix rates for telephone, light, power and other utility services which the farmers are installing in their homes."

Relationship Shown

In this connection the Public Utilities Commission of Maine has expressed in a novel and forceful way the relationship of the state, the public and the utilities.

"A public service company in its broadest sense is a partnership consisting of the state as an institution, the public as a group of customers and the company," say the commission in its sixth annual report. "The state determines the extent to which the company must go and regulates its rates, services and practices.

"The company furnishes the facilities with which these rights are exercised and services rendered. Those members of the public who constitute the customers furnish the revenue with which the company is enabled to perform these services. No public service company can exist without customers and those customers must be treated with fairness, both by the company and by the state."

PERSONAL NOTES

Frank A. Barbour, Consulting Civil and Sanitary Engineer, has associated with himself G. Gale Dixon, late Chief Engineer of the Bureau of Water Works Improvement of Akron, Ohio, under the firm name of Barbour & Dixon, with offices in the Tremont Bldg., Boston, and the Finance Bldg., Cleveland. The firm will continue practice in Mr. Barbour's specialty of hydraulic work, including water supply, sewerage and disposal of sewage, flood control, etc. Mr. Dixon has been connected with the development of Akron's water supply for about ten years; from 1912 to 1915 on design and construction of the original works under Mr. Barbour, in association with Mr. E. G. Bradbury, since which time he has been in complete charge of the enlargement of the system to meet the demands of Akron's remarkable growth.

Mr. S. F. Ferguson has withdrawn from the firm of Nicholas S. Hill, Jr., and S. F. Ferguson, Consulting Engineers, 112 E. 19th St., New York City. The firm was dissolved Aug. 31, 1922. The practice of the firm will be carried on by Nicholas S. Hill, Jr., as usual, at the above address.

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In all branches of telephone practice science has similarly contributed to economy. Even in such a comparatively small item as switchboard cords, improvements have reduced the cost of renewal by four million dollars a year.

Every new telephone added to the Bell System increases the usefulness of *all* telephones, but this multiplication tends likewise to increase the complications and the expense of service. The scientists of the Bell System, to offset this tendency, are constantly called upon to develop new devices which simplify complications and keep down costs.

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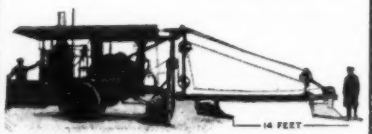

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Construction News and Equipment

REMOVING REINFORCED CONCRETE VENTURI VAULT WITH AIR OPERATED BREAKERS

Recently it was found necessary to remove the side wall and top of a large Venturi water vault and a section of the west wall of the Filter Building of the Cleveland, Ohio, water filtration plant.

A general view of the work, is shown herewith. The section of the west wall that was removed was 23 ft in length, 20 ft. in depth and 24 ins. thick. The wall was of concrete reinforced with ½ to ¾-in. bars, spaced on 8-in. centers. This made a very solid formation which was difficult to remove. Three days time was required to completely demolish this wall.

At the start, doing this work by hand was contemplated. However, Mr. Chas. H. McAllister, general manager of the Lake Erie Construction Co., to whom this contract was assigned, tried out an Ingersoll-Rand CC-25 "Paving Breaker." The "Paving Breaker" is an automatic compressed air operated pick and chiselling machine. It is similar to a non-rotating hand-hammer rock drill. It is light, extremely simple and operated by one man when working downward. In this particular case, however, it was found advantageous to use two men to each machine. Until lately "Paving Breakers" have been principally used by street railway, telephone, electric, power and gas companies for tearing up pavement of all kinds, for the laying and repairing of street railway tracks and the laying of electric cable ducts, gas mains, etc.

It required three days' time to completely demolish the west wall by the use of the two "Paving Breakers." As stated, two operators were used on each machine. The "Paving Breakers" not only broke up the concrete in pieces large enough to be handled by one man, but with the aid of a cutting chisel they also cut off the steel reinforcing side rods. These cutting chisels were similar to those used for asphalt except that the edge was concave so that it would not slip off the bar.

The side walls of the vault are 12 ins. thickness, 51 ft. long and 10 ft. high. They are reinforced in the same way as was the west wall of the filter building. These walls were removed in seven days by the use of the "Paving Breaker." The

REMOVING REINFORCED CONCRETE VENTURI METER VAULT WITH COMPRESSED AIR OPERATED "PAVING BREAKERS," AT WATER FILTRATION PLANT, CLEVELAND, OHIO.

roof of the venturi vault which was of the same dimensions and construction as the side was removed in 3½ days. This work would have taken many more men and a much longer time if hand methods had been used, and would of course, have been much more expensive.

We are indebted to Mr. M. A. O'Brien, Secretary and Treasurer of the Lake Erie Construction Co. of Cleveland, Ohio, for this information and for the photograph of the work. This work is in charge of Supt. Wm. Maloney of the same company.

HOW NORTH CAROLINA HIGHWAY COMMISSION MAINTAINS MOTOR EQUIPMENT

By Charles D. Farmer, Superintendent of Motor Equipment, North Carolina State Highway Commission, Raleigh, North Carolina

(Editor's Note: North Carolina has received about 750 war trucks, through the Department of Agriculture, ranging from the lightest type to the 5-ton Liberty, and 225 touring cars. There is at the "Truck Patch," maintained by the State Highway Commission, a complete machine shop, touring car and truck shop, all equipped with government furnished material. The present article by Mr. Farmer, telling how North Carolina cares for its motor equipment, is from a recent issue of the North Carolina Highway Bulletin.)

After a truck or car is allotted to North Carolina, it is driven away from the camp, or shipped, depending on proximity to the Truck Field. The car upon being received is entered on the inventory and a card made for the perpetual inventory file, and the car stored in the field, until such time as it is selected to be put through the shop. The perpetual card system carries all detailed information, such as: date received from Government, condition upon being received, the number of the shop job under which it is overhauled, the date that it was delivered to any particular district, the date of inspection by traveling inspectors, and the date of return by any district to Truck Field. The same information then follows the truck through another overhauling and issue. The cards are arranged numerically thus giving ready reference to the history of any particular truck or car.

The next move after a truck has been received is the selection by the shop foreman for its trip through the shop. The truck or car is put into the shop, the clerk giving a job card with number, of which he keeps a record, then the mechanic, assigned to the job, begins dismantling. The shop inspector checks off on the job card such parts as are to be overhauled or repaired, such as wheels, chassis, motor, radiator, or if general overhauling he so marks the card of instruction and the mechanic is governed accordingly.

The mechanic after dismantling the truck makes a list of such parts as he will need to replace broken or worn part. The shop foreman then makes requisition on the stock room for such parts, retaining in the shop the duplicate sheet which is filed with the job while open. The mechanic receives necessary parts from the stock room and signs requisition as receipt to stock room clerks for parts issued.

The time cards of mechanic and his helper, after being O.K'd by shop foreman, are filed in the envelope containing card of instruction, the duplicate of requisition on the stock room. During the time that the job is open the foreman and shop inspector pass on the work and note the progress of the job. After being finished the truck is turned over to the inspector for the road list. If the operation and condition of the truck are satisfactory the job is passed on. If, however, anything is found to be wrong or unsatisfactory the job is turned back to the mechanic.

Upon the final completion of the overhauling the car is parked among those ready to be issued to the various districts. The shop job is turned into the office, where the pricing or inventory clerk takes it into hand. This clerk gets the original requisition from the stock room clerks and compares it with the duplicate from the shop, then prices various items and deducts from inventory of stock on hand. The complete job records of parts and time is totalled, and turned over to the general ledger clerk, who in turn enters on the shop job record, then to the general ledger of distribution of charges. All repairs or overhaul jobs on trucks or cars, received from the Government are charged to "Original Repairs." This account for the first year of operation amounts to approximately $225,000, and covers all of the equipment issued out to the districts.

The perpetual, numerical inventory of trucks carries the job number, which refers to the shop job record, which in turn refers to the original shop records as turned into the office by the shop foreman. By reference to these records any information desired is at hand, so that in case of

any future complaint the true facts can be obtained, both as to the mechanic, the parts used and repair work done, and the O.K. of shop inspector, shop foreman, and road inspector.

Upon authority a truck or car is issued to any department or district, by a blue card issued by the office, carrying the make, motor, serial numbers, amount of gas or oil and accessories. The shop foreman O.K.'s this card, the office, after receiving signature of the one driving the equipment away, O.K's the card, then the gate keeper after inspection and verification of all numbers and information O.K's the "blue card."

The delivery now having been completed the blue card is turned into the office, at the end of the day with list of all deliveries, by the gate keeper and a new record is started on the truck or car, that is the record of operation.

The driver of each piece of equipment is required to make daily reports of all gas, oil, grease and repairs used to the Department or District Office. They in turn make weekly report to Motor Equipment Department Office, on blanks furnished, concerning each day's operation costs, work done and if idle the reason therefor. These reports are posted in detail on the "Individual truck record ledger." making a complete, permanent record of truck cost of operation, work done and miles traveled.

At the end of each month the record of each truck is totalled, the aggregate of the individual trucks and cars taken, thereby giving total cost of the Departments or Districts touring cars, trucks and tractors. These district records are then compiled into grand total for the State, and we arrive at the monthly cost per mile to operate touring cars, trucks and tractors. This monthly aggregate being added to previous months gives average cost covering any particular period of time, or the fiscal year or any part thereof that may have transpired.

When a truck or car is turned back into the Truck Field for exchange for a new truck or for overhauling, the same operation is gone through with in the process of getting it ready for re-issue, except that all charges for overhauling or repairing are charged to the particular work that the piece of equipment was on at the time it was turned in, either to Federal Aid Construction, State Highway Construction, Maintenance or Administration, in any given district.

It has often been stated, by those not acquainted with cost of preparing Government trucks for service, that it would have been cheaper and better to have bought new trucks than to have attempted to put into operation the trucks and cars given by the Government. On June 15, there were out in the State in service, and service of the very hardest and most trying kind, 221 touring cars, 392 trucks, 28 tractors and 41 motorcycles. Fixing the average purchase price of these, if they had been bought new, at $3,000 for trucks, $500 for touring cars and $150 for motorcycles and $4,000 for tractors, the total cost would have been; trucks $1,176,000, touring cars $110,500, motorcycles $6,150 and tractors $112,000, making a grand total of $1,404,650. We have seen that original repairs to date are $225,000, a saving of $1,179,650. This is a very conservative cost of such equipment as is now out in the State in service, and does not take into consideration any of the hundreds of pieces of equipment now stored at Truck Field, that have never gone through original repairs.

There are at present two traveling inspectors out in the State, who systematically go over the equipment in each district. These inspectors are authorized to stop and inspect any piece of equipment belonging to the State Highway Commission. Trucks are closely inspected and a detailed report made to the superintendent of Motor Equipment, a copy of the report being furnished to the district engineer, and another copy retained by the inspector.

The inspectors instruct drivers in the proper care and maintenance of equipment, and recommended any repairs or changes that they deem necessary. This system of inspection enables the superintendent of Motor Equipment to keep in close touch with all equipment and to know conditions surrounding each individual car or truck.

VALUABLE TRADE LITERATURE

Excavator and Loader.—"Lower Your Excavating Costs" is the title of an illustrated folder recently published by the T. L. Smith Co., of 1180 32nd St., Milwaukee, Wis. It features the fact that contractors who are using these machines for many kinds of work—drag-line excavating, cellar digging, excavating sand and gravel, stripping, and miscellaneous earth handling—are saving considerable time and money. Illustrations show how contrac-

tors are able to keep their wagons out of the hole and how they eliminate the need for building and maintaining an incline. The new truck-type, 4-cylinder motor of 4-in. bore and 5-in. stroke, now used, is also shown.

Chemical Lime.—"Lehigh, the Chemical Lime," is the title of a 20-page 6x9-in. pamphlet recently issued by the Lehigh Lime Co., 111 West Washington St., Chicago. It deals primarily with progress in the manufacture of lime and discusses the characteristics, advantages and uses of Lehigh chemical lime and hydrated lime.

Concrete Road Reinforcement.—A 6-page folder on the use of flat sheets for reinforcing concrete roads has been issued by the Truscon Steel Co., Youngstown, Ohio. Special reference is made to the fact that Pennsylvania and New York always specify flat sheets. Truscon Dowel Contraction Joints and Truscon Curb Bars are also illustrated and described. Attention is also called to the use of Truscon Standard Buildings for housing the machinery and storing the utensils used in municipal and county construction and maintenance work.

Speed Controller for Motor Vehicles.—The Hill Automatic Speed Controller for automobiles and trucks is illustrated and described in a folder recently issued by Henry C. Hill, 621 Main St., Cincinnati, Ohio. The controller may be driven from a front wheel like a speedometer. It can be adjusted to limit the speed of the machine from 12½ to 40 miles per hour, but permits the motor to run at its maximum speed and power capacity while making up grades with heavy loads. The device has been thoroughly tested and perfected under service conditions.

"Trail-Ford, the Super Truck," is the title of a small illustrated pamphlet recently issued by the Automotive Utilities Corp., 408 Detroit Savings Bank Bldg., Detroit, Mich., pertaining to a trailer especially designed to be attached to a Fordson tractor. The trailer may be easily equipped with a Winsor gravity end or side dump body, platform stake body, street flushing or water tank, etc.

Texaco Asphalt Macadam.—The Texaco Asphalt Macadam booklet has been slightly revised and was recently reprinted, the original edition having become exhausted. The booklet contains much of interest concerning the asphalt macadam road and is of practical value. It was prepared especially for the busy man whose time for reading is limited. It gives the essential information clearly and adequately, but in brief form. Every step in the construction of an asphalt macadam road is illustrated.

Crawler Crane.—The Link-Belt Crawler Crane is illustrated and described in literature recently issued by the Link-Belt Co., 910 S. Michigan Ave., Chicago.

Truscon Building Products.—A 100-page, 3½x6-in. booklet on Truscon Building Products has been issued by the Truscon Steel Co., Youngstown, Ohio. It contains illustrations and descriptions of all the numerous forms of Truscon building products and their uses. It also contains much tabular data for the use of designers.

Snow Plow.—The Champion V-Type Snow Plow is illustrated and described in a 4-page pamphlet recently issued by the Good Roads Machinery Co., Inc., Kennett Square, Pa. The pamphlet, designated as Bulletin K. D. V., shows close-up views of the snow plow and its use. This type of plow is especially designed to attach to heavy tractors with sufficient power for pushing through heavy masses of snow.

Power Hoe.—The Link-Belt Power Hoe, for storing and reclaiming materials, is illustrated and described in booklet No. 444, recently issued by the Link-Belt Co., 910 S. Michigan Ave., Chicago. The Power Hoe makes possible the storage and reclamation of coal, gravel, sand or similar materials at a very small cost per ton handled.

Steel Pipe Couplings.—Dresser Steel Pipe Couplings for Water Lines are fully illustrated and briefly described in a folder recently issued by the S. R. Dresser Manufacturing Co., of Bradford, Pa.

How to Construct a Sheet Asphalt Pavement.—No highway builder's file is complete if it does not contain a description of the construction of a Sheet Asphalt pavement, the highest type of asphaltic construction. Perhaps you have laid this type of pavement; possibly you have not. In either case you will find the "Texaco Sheet Asphalt" booklet to be a valuable addition to your file. Simply, thoroughly, directly, it tells its story. And it makes a neat and attractive appearance which is in keeping with any road builder's file. It is illustrated by photographs and cross-sections which bring out the important points in the text. It is published by the Texas Co., Asphalt Sales Dept., 17 Battery Place, New York City.

Contracts Awarded

ROADS AND STREETS

Ala., Carrollton—Thompson & Donahoo, Tuscaloosa, Ala., awarded contr. for road constr. in Pickens Co., at $60,000.

Ariz., Holbrook—Winsor & Frost, St. Joseph, awarded contr. to constr. Holbrook-St. Johns Hwy.; FAP 42, at $37,291.

Ariz., Tucson—Goodman Merrill Co., St. David, awarded contr. for surfacing highway bet. Superior and Florence—about 5 miles, at $28,965.

Cal., Fresno—T. A. Hanrahan, Griffith-McKenzie Bldg., Fresno, awarded contract to pave 10.14 mi. county hwy. on Biola Rd., at $168,999.

Cal., Glendale—Geo. R. Curtis, 2440 E. 26th St., awarded contract for paving Harvard, Hawthorne and Orange Sts., at abt. $24,059. Ducey & Breitenstein, 151 S. Hill Ave., Pasadena, award. contr. for paving W. Bway., Concord St. and San Fernando Rd., at $23,080.

Cal., Los Angeles—W. L. Miller, 756 S. Broadway, awarded contr. for paving Holly Dr., at $2,420; Napier & Simpson, San Fernando, contr. for grading roadway and constructing walks, etc., in 105th, 106th, 107th and 109th Sts., Budlong, Normandie, Harvard and Western Aves., at $57,694; L. A. Pavg. Co., 2900 Santa Fe Ave., contr. for paving portion Vernon Ave., at $5,558; Fairchild-Gilmore-Wilton Co., L. A. Ry. Bldg., awarded contr. for paving Grand Ave.—4th to 24th Sts.—San Pedro, at $88,627; also contr. for paving portion of St. Andrews Pl., at $31,277.

Cal., Orange—Wells & Bresslar, Santa Ana, awarded contr. for paving Chapman Ave.,—Cambridge St. to east city limits—with 8-in. cem. conc. and belt finish wearg. surf; also constr. of two culverts, at 27 75c sq. ft. for paving, $500 for culverts. Job is 4,600 ft. long, 42-ft. streets, approx. 202,000 sq. ft.

Cal., Pasadena—Ducey & Breitenstein, 151 S. Hill St., Pasadena, awarded contract for impvt. of Raymond Ave.,—Orange Grove Ave. to Dakota St., Pasadena, at $118,890.

Cal., San Diego—Louis Salcido, La Jolla, awarded contract for paving Roosevelt Mem. Dr., no. of La Jolla, at $24,840, involving about 108,000 sq. ft. 5-in. cem. conc. pavement at 23c ft.

Cal., Sacramento—Isbell Constr. Co., Fresno, awarded contract for grading 11.31 miles of highway bet. Chester in Plumas Co. and Westwood, Lassen Co., at $116,227. Geo. Pollock Co., City, awarded contract for grading 3.28 mi. 21-24 ft. roadway in Ventura Co. bet. Hueneme Rd. and 3¼ mi. s.e., at $33,640.

Cal., Stockton—Clark & Henery Co., Stockton, awarded contr. to constr. asphalt conc. surface rd. in Santa Clara Co., 4.35 miles long, at $48,588.

D. C., Washington—Cranford Paving Co., City awarded contr. for paving with asphalt a number of sts. here at approx., $75,000.

Fla., Gainesville—Hutton Engrg. Co., awarded contract to lay sheet asph. and asph. conc. at $375,000.

Fla., Quincy—W. P. Kennedy Constr. Co. King St., awarded contr. for impvt. of Jefferson, Roberts, King and Washington Sts., at $77,582.

Ga., Savannah—Dixon Contracting Co., Savannah, Ga., awarded contract for paving various thoroughfares at $233,000.

Ill., Glen Ellyn—E. M. Schoflow, Elgin, awarded contract for paving Western Ave. here, at $95,000.

Ind., Crown Point—H. P. Downey, Hammond, awarded contr. for the Adolph Lottes Rd., in Center, at $39,585; Henry Hathoway, Lowell, awarded contr. for Emerson O. Sutton Rd., in West Creek, at $34,900; See Teaming & Supply Co., Hammond awarded contract for Hawkinson Rd., Hanover, at $33,750; Courtright, Heiney & Wheeler, awarded contract for the Geo. Milcher Rd., in Winfield, at $35,000.

Ia., Sioux City—M. L. Flinn, awarded contract by City Council, for paving Country Club Place streets, at $80,000. Vibrolithic concrete will be used.

Ia., Waukon—Thos. Carey & Sons, E. 6th & Market, Des Moines, awarded contract for 50 blks. asph. conc. 5-in. base of conc, and 2-in. asph. top

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at $2.41 per sq. yd., 24-in. curb and gutter at 88c. Total, about $134,098.

Ky., Frankfort—Costello Bros., Knoxville, awarded contract for 8.3 miles on Greenville-Nortonville Rd., Greenville, west, at $42,054; Bremen, Costello Bros. contr. for 6 miles on Central City-Calhoun Rd., Muhlenberg Co., at $42,910.

Ky., Louisville—Bd. of Awards let contracts as follows: Louisville Asphalt Co., at $90,000 for paving portions of Berkenmeier Ave., Keats Ave., 23rd St., Walnut St., Rawling Ave., Zeigler Ave. and Struck Ave.; Henry Bickel Co., contr. for paving portions of 6th, Howard, Rosewood streets; also fill sq. called quadrant from Edenside to Eastern Parkway, at $40,000.

Ky., Louisville—Following road contracts let by State Hwy. Commission: R. G. Hill & Co., awarded contr. for Catlettsburg-Louisia Rd., Boyd Co., at $202,539; (pen. sandstn. base, vit. pipe); Dempster Constr. Co., Paintsville-Saylersville Rd., Johnson Co., at $161,138; also contr. to same firm for Beattyville-Irvine Rd., Lee Co., at $115,258; U. S. Tackett, contr. for Hyden-Hazard Rd., at $57,240; Dempster Constr. Co. contr. for Sec. A, Jenkins-Haymond Rd., Letcher Co., at $45,102; also contract for Sec. B, Letcher Co., Ermine-Mayking Rd., at $41,625, and Salyersville-Paintsville Rd., Magoffin Co. at $82,996; Costello Brgs. Co., contr. for Sec. B, Muhlenburg Co., Central City-Calhoun Rd., at $42,910; also contr. for Sec. C, Greenville-Mortonville Rd., Muhlenburg Co., Sec. C, at $42,054; Southern Oil & Tar Co., contr. for Mt. Vernon-London Rd., Rockcastle Co., at $67,270; Dempster Construction Co., Pikesville-Williamson Rd., Pike Co., at $41,450; bridge constr. in Johnson Co. (Big Paint Crk.) and Lee Co., (Big Sinking Crk.) to Brooksville Bridge Co., at $13,911 and $6,240; Paint contract to E. E. Price & Co., Nicholas Co., at $33,858, Maint. contr. Warren Co. to J. B. McClellan, Bowling Green, Ky., at $13,509; surface treat. Bath Co., to Eaton Oil Wks. Boyle Co., contr. to Southern Oil & Tar Co., on tar, Eaton Oil Wks., Clark Co., on oil; R. B. Tyler & Co., contr. on tar Franklin Co. Southern Oil Co., contracts on tar in Hardin, Hart, LaRue, Madison Counties; R. B. Tyler Co. on tar in Woodford Co.

Ky., Louisville—A. J. Wardrep, awarded contract for 5.91 mi. St. Hwy. in Cumberland Co., N. C., at $161,275.

La., Baton Rouge—M. L. Bonner, New Orleans, La., awarded contr. to build gravel surf. rd. from city limits to Weller Ave. at $130,000.

Md., Baltimore—State Roads Comn. let following contracts: 2.01 mi. conc. rd., Frederick Co., to Bester, Gosnell & Russell, Hagerstown, Md., at $63,201; 2.95 mi. conc. rd. Allegany Co., to S. T. Brotemarkle, Cumberland, Md., at $120,818; St. Marys Co., 3 mi. gravel rd. from Harper's Cor., toward Laurel Grove., to St. Mary's Constr. Co. at $20,736; 1.03 mi. conc. rd. Anne Arundel Co. to Christhilf and Ensey, 1625 Ridgely St. Baltimore, at $25,504; Prince George's Co. 1 mi. conc. rd. to Ward and O'Connell, New Amsterdam Bldg. Baltimore, at $27,248, Dorchester Co. 1 mi. conc. rd. near Lloyds, to Phillips & Neal, Hurlock, Md.; 2 mi. gravel rd. near Lyons Cor., Charles Co., to H. S. Swann, La Plata, Md., at $27,848; Hartford Co., 1.89 mi.—Aberdeen toward Stepney, to Development & Constr. Co., American Bldg., at $55,543; Worcester Co., 1.72 mi. from Bishopsville to Bishop Sta., to Juniata Constr. Co., Philadelphia, at $44,445; Montgomery Co. .97 mi. Flower Ave., Takoma Park, to Corson & Gruman, Washington, D. C., at $26,517; Garret Co. 1.99 mi. from Gortner to Red House to F. J. Denison So., Washington, D. C., at $60,836; Somerset Co., 1.8 mi. from Marion toward Tulles Cor. to D. A. Hannaman Constr. Co., Salisbury, Md., at $49,542.

Mich., Holland—Gable & Gable, awarded contract by Ottawa Co. Rd. Commrs. for bldg. 8½ miles state reward road on trunk line M89, at $76,600.

Minn., Madella—Johnson, Drake & Pipe, 905 Plymouth Bldg., Minneapolis, awarded contr. for paving streets, at $88,537.

Mo., Benton—Norman Davis, Sikeston, Mo., awarded contract by St. Hwy. Dept. to build 16 ft. gravel hwy. across Scott Co. through Sikeston, FAP No. 5, at $83,007.

Mo., Kennett—W. A. Leach, Poplar Bluff, Mo., awarded contr. for bldg. 17 miles conc. highway at $260,000.

Mo., Kansas City,—E. L. Meek & Co., Kans. City, Mo., awarded contr. for hard surfaced road in Jackson Twp., at $82,691.

Mo., Poplar Bluff—W. A. Leach, local, awarded contract for constr. of a stretch of conc. hwy. near Kennett, 17 mi. at $260,000.

Mo., St. Louis—List & Gifford, Alton, awarded contract for paving Wood River-Edwardsville road, at $118,037.

Mo., St. Charles—Strubel & Helmick Contracting Co., Alton, Ill., awarded contract for paving Clay St. and putting in curbs and gutters, at $79,745.

Neb., Newman Grove—Asplund Constr. Co., Tecumseh, awarded contract for paving streets here at $46,978.

N. Y., Brooklyn—Following contracts let: Repaving Church Ave. to Borough Asphalt Co., 407 Hamilton Ave., at $27,013; Porter Ave., etc., and Ralph Ave., Macon to Atlantic Ave., to Sicilian Asph. Pavg. Co., 41 Park Row, N. Y. C., at $3,215 and $56,340, respectively.

N. Y., Watertown—G. Aubrey Smith, Lowville, awarded contract to build 3-mile stretch of conc. hwy. to be laid on Lowville end of Lowville-Carthage Rd., at $88,689.

N. C., Charlotte—Noll Construction Co., awarded contract to construct 7 miles Yorkville Rd., hard surfaced, at $186,000.

N. C., Graham—Elliott, Sholes & Co., Durham, awarded contract for grading and conc. paving 4 miles rd. at $97,700.

N. C., Henderson—R. G. Lassiter & Co., Oxford, N. C., awarded contr. for Warrenite bitulithic paving here, at $189,720.

Wentworth, N. C.—Noll Constr. Co., awarded contract to build 7 mi. on Yorkville Rd., at about $186,745.

O., Cleveland—Roehl Bros., awarded contracts by County Commrs. for 5 miles new brick paving on Lorain Ave. and Riverside Rd., in West Park, at $524,000.

O., Columbus—T. P. Fitzgerald, Ashtabula, awarded contract for grading, bridging and paving with brk. 10.297 mi. Sec. "C-1" Painesville-Warren Rd., Ashtabula, at $299,077.

O., Toledo—Following contracts for constr. of roads let by Co. Commrs.: Upton Ave., sheet asph. to Continental Bitumen Co., at $114,191; Cone St., $12,768, rein. conc., to J. K. Sheridan; Milburn Ave., $6,440, rein. conc., to Thos. F. Carrigan Co.; Freeman St., $20,811. rein. conc., to J. M. Sheridan; McCord Rd., $66,496, bitum. macadam, to Warner & McKechnie; Reynolds Rd., $34,898, bitum. macadam, to Arthur Langenderfer; Wychwood Rd., $12,331, rein. conc., to Peters Bros.

Okla., Okla. City—Green Constr. Co., awarded contract by St. Hwy. Dept., to build 7 miles 7-in. one course conc. surf. rd., west towards El Reno to Canadian Co. line, FAP., at $226,000.

S. C, Sumter—Pritchard, Raines, Hazlehurst, Savannah, Ga., awarded contract for constr. of 7½ mi. hwy. 5-in. conc., covered with 2-in. asph., at $215,000.

N. Y., Brooklyn—Following contracts let: Repaving Church Ave., to Borough Asphalt Co., 407 Hamilton Ave., at $27,013; Porter Ave., etc., and Ralph Ave., Macon to Atlantic Ave., to Sicilian Asph. Pavg. Co., 41 Park Row, N. Y. C., at $3,215 and $56,340, respectively.

Ore., Roseburg—A. C. Hanson, awarded contract for constr. of Scottsburg-Hill Crk. Section of Roseburg-Reedsport Hwy., at $52,378.

S. C., Charleston—Poe Constr. Co., Greenville, S. C., awarded contract to build 2.171 mi. plain conc. rd. at $55,000.

Tenn., Nashville—J. F. Marcum & Co., Knoxville, awarded contr. for surfacing 10.04 mi. road from Rockwood to Kingston, FAP. 85, Roane Co., at $277,309.

Tex., Breckenridge—McCollum Constr. Co., Fort Worth, Tex., awarded contract by Stephens Co., to asph. surface 17 mi. Breckenridge-Ranger Rd. thru Co., at $200,000; also contr. for constr. of waterbound macadam base with penetration top on 17 mi. Eastland Rd., at $92,868.

Tex., Cameron—Thomas & Ratcliff, Rogers, Tex., awarded contr. to gravel surf. 17.94 miles St. Hwy. 36, at $80,743, County to furnish 39,765 cu. yds. surfacing.

Tex., Dallas—Tibbets Constr. Co. awarded contr. for gravel conc. pavement on Seagoville Rd., at $71,507.

Tex., Georgetown—Contracts awarded as follows for road work: 11.6 mi. gravel surfacing on Taylor-Thorndale Rd., 18 ft. wide and 12 in. thick, to Henry Kyle, Hutto, at $76,596; 9.4 mi. gravel surfacing on Georgetown-Jarrell Rd., 16 ft. wide and 10 and 12 in. thick, to McDonald & Evans, Austin, at $51,433.

Tex., Edinburg—Uvalde Rock Asph. Co., City Natl. Bank Bldg., award. contract to build 34.5 miles State Hwy. 12—Edinburg to Brooks Co. line; gravel surfacing with 1-in. bitum. topping, at $250,000.

Tex., Waco—Wear & Thomas, Rogers, awarded contract for gravel macad. with asph. treat. on Dallas Rd., at $164,762; also constr. of portion of Mart Rd. with asph. surf. treated gravel, at $58,834. Surfacing will be done by Finley Method Co., Atlanta, Ga. Texaco asph. will be furnished by County. Manton Hannah, Co. Engr.

Wash., Bellingham—Denning & Burnet, awarded contract to build 9.1 mi. of road in Mount Baker Dist., at $169,061.

Wash., Seattle—A. Tocco & Co., awarded contract for paving 3rd Ave., N. W., at $178,742.

SEWERAGE AND SEWAGE TREATMENT

Ark., Pine Bluff—McEachin & McEachin, Little Rock, awarded contract for constr. of sewers in Dist., at $52,000.

Conn., Bridgeport—Sewer Comn. let contract for storm, san. and comb. type sewers in Park, Essex, Horace, Bradley and Kent Sts., Ridge and Sage Aves., to Bridgeport Constr. Co., 983 Broad St., $30,092; Harvard, 5th, Hope, Monroe, Clarkson, Dixon, Kelsey Thorne, Willow & Hewitt Sts., Nash & Church Lanes, Garden Ter., Davis & Jewett Aves., to Pierce Mfg. Co., 785 Housatonic Ave., at $21,175.

Fla., Miami—Deer & Co., Miami, awarded contract for san. sewer construction, at $150,000.

Ind., Portland—Kohlsbarger & Hoyle, Marion, awarded contract for Miller Branch sewer, at $66,396.

Ia., Sioux City—D. E. West, Sioux City, awarded contract for construction of extensive storm water sewer on Harrison St. Leeds, at $35,000.

Kans., Kansas City—T. M. Torson Constr. Co., awarded contr. for construction of largest storm sewer in Kansas City,, at $145,810. Sewer will be constructed of brick and will be 2 miles in length, diam. 72 ins. at outlet.

Ky., Louisville—H. Bickel Co., 443 Garden St., awarded contr. for sewer and drain in Speed Ave., at $64,470; 44th St. and Parker Ave., sewers to C. H. Cahill, 1540 9th St., at $27,999.

Mich., Detroit—Contract let to W. Blanck & Co., 823 Ford Bldg., for Lat. sewer 3515, at $9,945; 3673-A, $36,561; 3678, $10,490; 3683, $14,471; 3691, at $11,892; Lennane & McIlvenna, 1205 Book Bldg., contr., for 3672 at $15,500; 3685 $8,000; 3697 $2,000; 3693, $5,900; 3698, $6,900; Detroit Drainage Constr. Co., Penobscot Bldg., 3676, at $15,775.

Minn., Brainerd—Riches & Son, Superior, Wis., awarded contr. to construct new san. and storm sewer in southeast Brainerd thru a ravine to the river, at $38,908.

Minn., Eveleth—Lawrence McCann, Eveleth, awarded contract for septic tank, at $257,900.

Neb., Grand Island—Sewers and sewer disposal plant, Sects. 1 and 4, awarded to M. J. Peterson, 1119 S. 35th St., Omaha, who sublet same to Ward and Weighton, 516 Davidson Bldg., Sioux City, at $61,846; Sec. 2 to C. L. Hansen, Charles City, Ia., $131,274; Sec. 3 to Chambers Constr. Co., Grand Island, at $41,181; Sec. 5 to Hansen & Willodsen, Omaha, at $35,718.

Neb., St. Francis—Asplund Constr. Co., Tecumseh, awarded contr. for sewer and disposal plant, at $35,953.

N. J., Hackensack—Public Service Production Co., awarded contract for bldg. sewer disposal plant here, at $481,000.

N. Y., Mt. Kisco—Contract for resanding existing filter beds and (2) constructing new filter beds at Mt. Kisco sewage disposal plant near here, Westchester Co., to Carroll Contg. Co., 103 Park Ave., New York, (1) $38,426; (2) $42,987.

Okla., Okla. City—Smith Bros., Dallas, Tex., awarded contract for constr. of Lee Ave. sewer, at $490,309.

Pa., Pittsburgh—Christ Donatelli awarded contract for Spring Garden Ave. sewer sys., at $39,072.

S. C., Charleston—Bryan & Co., Jacksonville, awarded contr. for extension and completion of sewerage sys., at $371,895.

S. Dak., Gregory—E. M. Scheflow, Elgin, Ill., awarded contract for sewer, at $62,000.

Wis., Milwaukee—Midwest Constr. Co., Milwaukee, awarded contr. for constr. of 1st intercepting sewer of Metropolitan Sewerage Comn., at $113,776. Sewer will be 7,900 ft. long.

WATER SUPPLY AND PURIFICATION

Cal., Dinuba—Pittsburgh-Des Moines Steel Co., Rialto Bldg., San Francisco, awarded contract for erecting steel tank and tower for water works system, at $13,425.

Cal., Marysville—Bent Bros., 1714 Eagle St., Los Angeles, awarded contract to constr. concrete constant angle arch overflow dam and reinf. conc. power house at Bullard's Bar, about 40 miles n.e. of Marysville for Yuba Development Co., Hobart Bldg., San Francisco, at $343,654. Dam will be 175 ft. high, 35 ft. thick at base and 6 ft. at top. It will carry a 16-ft. roadway abt. 600 ft. long, similar to that on Devil's Gate at Pasadena.

Cal., So. San Francisco (San Francisco P. O.)—MacDonald & Kahn, 130 Montgomery St., San Francisco, awarded constr. for conc. tank reservoir, 200,000-gal. capy. and 1 mile c.i. pipe, at $40,000.

Que., Montreal—F. G. M. Cape & Co., Ltd., 10 Cathcart St., award. contracts for constr. of reservoir, at $575,000; gate valves and appurts., to Crane, Ltd., St. Patrick St.; sluice gate and appurts., to Dominion Bridge Co., Ltd., Lachine; etc.

Ont., York Twp.—Contracts for 6-in. water mains, at $30,000 award., to W. E. Taylor, 22 Falcon st., Toronto, Russica Bros., 256 Ontario, and A. Cavetti, 257 Euclid Ave., Toronto.

Fla., W. Palm Beach—L. C. Hishler, awarded contract for laying and installing pipe line complete for high pressure fire system, at $15,700.

Ill., Maywood—S. B. Geiger, 330 Old Colony Bldg., Chicago, awarded contract for drilling artesian well, at $25,662.

N. D., Valley City—Haggart Constr. Co., Fargo, awarded contract for water mains, reservoir, sewers, etc.: water works, reservoir, etc., $90,581; sewers, $22,653.

Md., Baltimore—O. G. Ligon, awarded contract for digging 3½ mi. ditch for water main of proposed reservoir on Reistertown Rd., at $57,000.

Mich., No. Branch—Pittsburgh-Des Moines Steel Co., Pittsburgh, awarded contract for constr. and installation of water works plant and distributing system, at $28,107.

Minn., No. St. Paul—J. J. Connolly, 1007 Reaney St., St. Paul, award. contract for water works extensions and electrification of pumping plant; 36,000 lin. ft. cast iron pipe, etc., at $50,000.

Mont., Harlem—J. P. Murphy, Great Falls, awarded contract for filtr. plant and 8,000 lin. ft. 6-in. cast iron mains, at $42,680.

N. Y., Raybrook—J. J. Fitzpatrick & Sons, 84 Bridge St., Plattsburg, awarded contract by State Hosp. Comn., Albany, for addn. and alterations to water supply system at N. Y. State Hospital for incipient tuberculosis here, at $19,192.

N. C., Taylorsville—Electrical Constructors Co., Charlotte, N. C., awarded contract for water and sewer systems, also reservoirs, wells and equipt., at $63,418.

Okla., O'Keene—H. H. Dobe, local, awarded contr., at $3,500 for well and power house; Allis-Chalmers Co., Dallas, contract for engine and generator set, at $18,800, and Dwight Chapin, Jr., Wichita, Kans., contr. for elec. distribution and white way, at $15,500.

Okla., Okla. City—Tibbets & Pleasant, Tulsa, awarded contract for purification plant, at $282,700.

Pa., Philadelphia—A. DeSandro & Son, 3906 N. 50th St., awarded contract for laying 6, 8 and 12-in. cast iron pipe, at $31,174; furnishing 6, 8 and 12-in. cast iron pipe to R. D. Wood & Co., 300 Chestnut St., at $64,100; furnishing 6, 8 and 12-in. stop

valves to W. E. Cooney Co., 519 Arch St., at $18,106; furnishing and laying 30-in. steel pipe to A. J. Ellis, 5724 Marshall St., at $21,151.

S. D., Mitchell—Porett & Tuttle, Mitchell, awarded contract for water main extensions, at $34,479.

Tex., Colorado—W. Weeks, Arlington, Tex., awarded contract to complete water works and sewer system, at $32,000.

Tex., Dallas—Hess & Skinner, Engrs., awarded contract thru Myers & Myers, for extending water mains of Highland Park water sys. into Mt. Vernon addn., at $10,000.

Wash., Morton—Auburn Constr. Co., Auburn, awarded contr. for installing Connolly Creek gravity water sys., at $16,000.

Wash., Seattle—Paduano & Co., awarded contract for water mains in Lucile St. et al., at $50,819.

Wis., Blue Mounds—Ayem, Petersen & Rue, Main St., Mt. Horeb, awarded contract for rein. conc. reservoir, laying mains, installing and furnishing equipt. for water works system. Engineer's est. $25,000.

Prospective Work

PROSPECTIVE WORK—ROADS AND STREETS

Cal., Los Angeles—City Engineer Griffin, Los Angeles, is preparing to pave 16 streets in Hollywood dist., west of Hoover Street and no. of Melrose Ave.

Fla., Tampa—Hillsborough County has voted bond issue of $3,000,000 for bldg. 160 miles hard surf. rds. in County.

Ill., Moline—City Council approved Ords. providing for 9 impvts. at est. cost of $237,191. There are 5 paving projects, 3 of which are alleys, one sewer and one water main proj. and 2 big resurfacing projects included in the impvts. Largest of the 9 impvts. is the 17th Ave. paving district, total est. cost of which is $75,587.

Ia., Des Moines—Board of Supvrs. Sac County, have authorized paving 12 additional miles.

Kans., Topeka—Shawnee Co. Commrs. directed A. C. Lagerwall, Co. Engr., to make est. of cost of paving Dover Rd.—Topeka to Wabansee Co. line thru Dover Twp.

Kans., Topeka—Included in fed. aid road allotments, passed by Kans. St. Hwy. Comn., is $325,000 for impvts. and hard surfacing work on Southwest Trail Hwy. from Topeka to Dover—20 miles. It is specified that road shall be built of concrete or macadam. Definite action towards constr. of rd. will be taken in near future. Allowances by St. Hwy. Dept. for roads are: $60,000 appropriation for 1922 for grading and culverts; $145,000 during 1923 for surfacing and bridges and $120,000 during 1924 for surfacing. Total est. cost of road $600,000. Harper Co. has been allotted $105,000 for 7 mi. conc. rd.; Linn Co. $37,500 for bridges on 7.28 mi. no. & west of La Cygne & $21,841 for grading and culvts. same rd.; Allen Co. $31,610 for 7½ mi. conc. Iola-Humboldt Rd.

La., Monroe—It is planned to divide Morehouse Parish into two road districts and call an election in September to vote on $1,100,000 road bond issue.

Miss., Jackson—Approx. $780,000 has been allotted from fed. aid funds by state hwy., connecting St. Augustine, Fla., of Miss. link of Old Spanish Trail trans-continental hwy., connecting St. Augustine, Fla., with San Diego, Cal. Allotment was made to the 3 Counties thru which hwy. runs: Hancock Co., $200,000; Harrison, $200,000, and Jackson, $380,000.

Miss., Winona—State Hwy. Dept. has notified road commrs. here that Montgomery Co. has been allotted $100,000 fed. aid for road constr. in county.

Mo., Jefferson City—Contracts for grading and first work on 1,500 mi. state's good roads program will be let within a month. Dists. will be cut into 5-mile sects.

Mont., Great Falls—Cascade County will build road from Rainbow Falls power plant to Big Falls dam, Volta. F. C. Roosevelt, Co. Clk.

Mont., Havre—E. J. Doreen, Dist. Hwy. Engr., instructed by Bd. of Co. Commrs. to notify State Hwy. Comn. to ask bids for constr. of hwy. proj. 132—Gildford to 1 mile west of Rudyard on Roosevelt trail.

Neb., Lincoln—Plans for following approved by Government: Proj. 42, Sec. B, 5.11 mi. sand clay on Taylor-North Rd.; 87, Sec. A, 2.50 mi. gravel, Norfolk-Stanton Rd.; 88, Sec. B, Oakland-Crowell Rd., 1.10 miles sand-gumbo; 92 S. A., 3.38 mi. earth, Litchfield-Hazard Rd.; 98, S. C., 6.71 mi. earth, Crete-Dorchester Rd.; 139, S. A., Norfolk-Ewing Rd., 3.22 mi. gravel. Plans submitted for approval include 102, Sec. B, Smiley-Canyon Rd., 3.08 mi. earth rd.; 138, B, LaPlatte-Omaha, 8.46 mi. earth rd.; 176, Curtis-Maywood Rd., 5.9 mi. earth; project statement approved on 158, Atkinson-O'Neill Rd., 19 mi. earth; 174, Elm Crk.-Holdredge Rd., 2.8 mi. gravel, also 178, Gilmore-Omaha Rd., 2 mi. earth. Plans being revised on 6.63 miles earth, Springview-Ainsworth Rd., 197.

Okla., Ardmore—Carter Co. Commrs. will construct 11 miles Lee Hwy. connecting with Johnston Co. line, $85,000 pledged by Commrs., expect Fed. Aid for same amt.

Okla., Muskogee—Muskogee Co. Commrs. plan bldg. 17 miles of hwy. bet. Warner and Muskogee-Haskell Co. bridge, now under constr. across Canadian River at Briartown, est. cost $180,000. Commrs. have approved plans for 11 miles hwy. bet. Warner and Webber Falls. Surveys being made for 6 miles rd. east of Ft. Gibson on Ft. Gibson and Tahlequah, Cherokee Co. Rd. Approx. cost $30,000; 3 miles of rd. bet. Muskogee and Spaulding brdg. leading into Wagoner Co., $36,000; 6 miles rd. bet. Boynton, so. to Council Hill, $96,000; 2 mi. hwy. to close gap across Ark. River near Frisco Ry. brdg. in Jefferson Co. Will have both Fed. and State Aid.

Penn., Easton—Northampton Co. Commrs. have acted favorably on application of residents of 4 of the Twps. in northeastern west sect. of Co. to secure 25 mi. new cem. hwy. Est. cost abt. $875,000.

Tex., Austin—U. S. Bureau of Pub. Works, Washington, D. C., has approved bldg. 7.5 mi. St. Hwy. 10, bet. Benbrook and Parker Co. line; gravel surf. with 2-in. bitum. top. Approx. cost $120,500. R. V. Glenn, Co. Engr.; 8-mile, 16-ft. gravel rd., St. Hwy. 3 from LaGrange to boundary line of Precinct 4 in Fayette Co., Fed. Aid Proj. 285, $89,637. A. Schlaffle, Co. Engr.; 14.3 mi. St. Hwy. 6, Dallas Co., FAP. 288; surf. with asph. macadam 18 and 20 ft. wide, $535,000. Nagle, Witt-Rollins, Engrg. Co., Dist. Engrs.; FAP. 304, 8.6 mi. Austin-Fredericksburg Hwy., Travis Co. bet. Oak Hill and Hays Co. line, $36,685; FAP. 302, 5.6 mi. St. Hwy. 3-A, Austin-Bastrop Rd., Travis Co. bet. Onion Crk. and Bastrop Co. line, $18,238, O. Leonard, Co. Engr.; Bowie Co., K. B. Williams, plans 16.8 mi. gravel surf. rd., St. Hwy. 1, Cass Co. line to Rd. Dist. 3 line, $760,500. R. V. Curnutte, Engr.

Tex., Houston—Mayor Holcombe's Impvt. program has been adopted by City Council and more than $400,000 authorized for following impvts.: Graveling streets, $100,000; paving, $122,000; storm sewers, $112,000; san. sewers, $35,000, and storm sewers on 11th St. and Castle Court, $80,000.

Va., Clintwood—Dickinson County Bd. of Supvrs. has $400,000 available for completion of following projects: 10 mi. State Hwy. bet. Fremont and Haysi, $200,000; 8 mi. St. Hwy., Clintwood point up to George's Fork Crk. to Wise Co. line, $150,000; also $50,000 for Hwy. bet. Clintwood and Wise Co. line on rd. to Coeburn.

Va., Richmond—Chrmn. Shirley of Va. Hwy. Comn. has announced that $2,000,000 is now available for hwy. constr. in state. $400,000 appropriation is from Dickinson Co. for use on constr. of 3 hwys. Portsmouth's gift is $34,000 for bldg. 3½ mi. hwy. out of that city; appropriations of $100,000 from Buckingham and $50,000 from town of Halifax were received by the Comn.

Wash., Vancouver—Contract for No. Bank Hwy. —Underwood to Lyle—in which 11 miles new rd. will eliminate 15 mi. present route, will be let early in October. Road will be built with fed. aid and will be graveled.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitosiag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitosiag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

W. Va, Wayne—Lincoln District, Wayne Co., voted $150,000 bonds for impvt. of roads. Among first projects planned is impvt. of road bet. Marrowbone bridge and Butler line connecting Missouri branch, Dunbar, Ferguson, Radnor and Genoa. Contracts will be let in four separate sections in November.

SEWERAGE AND SEWAGE TREATMENT

Ala., Anniston—City will construct sewer system on various sts. and extend present system to Tyler Hill, So. Anniston to connect with Oxanna.

Ia., New Vienna—Plans under way for sewers and disposal plant. Cons. Engr. Howard B. Green, 634 Cedar Rapids, Savings Bank, Cedar Rapids. Geo. F. Gerken, City Clk.

Ky., Hazard—Plans and specfs. of complete new sewerage system for city being prepared and bids will be requested within 30 days. The J. N. Chester Engrs., Cons. Engrs. Union Bank Bldg., Pittsburgh.

Neb., Grand Island—Plans being prepared for Sewer Dist. 83, Dist. 86, Dist. 85 and Dis. 82. H. E. Clifford, City Clk.

Neb., Lincoln—Will install sewer in San Dist. 1, P. & Q. Sts., bet. State Street and Capital Beach. Est. cost, $9,000. Theo. H. Berg, City Clk.

La., New Orleans—Sewerage and Water Board voted to constr. extension of about 3,650 ft. conc. pipe to replace open drain in Toledano St.—Broad St. to S. Claiborne Ave. Extension will cost approx. $60,000.

Mo, Kansas City—Bd. Pub. Wks. has approved ord. for constr. of Blue Valley sewer comprising 360 separate sewer districts covering abt. 22,000 acres, in natural draing. area; at present time will constr. sewer in no section. $1,750,000.

Mo., St. Louis—Bd. of Pub Service is creating taxing dist., to construct River Des Peres sewer to cost $10,000. Ord. goes before Bd. of Aldermen September 15th.

Mo., Trenton—City plans forming new storm sewer district to drain about 49 acres. Est. cost about $8,080.

O., Canton—Plans being prepared, and specfs., for new addition to sewage disposal plant. $700,000. McClasky & Reese, Canton, Engrs.

O., Marion—$550,000 bonds voted here for constr. of trunk line sewer.

Pa., Jersey Shore—Town contemplates constructing sewage disp. plant. $25,000. Engr. not announced.

Pa., Pottstown—City considering issuing $200,000 bonds for sewerage system and sewage disposal plant.

S. C., Gaffney—Bd. of Public Works will extend 8-in. sewers; 8-in. terra cotta pipe. Construction by city forces.

S. D., Gregory—Citizens voted in favor of constr. of modern sewer system.

Tenn., Knoxville—City has petitioned Legislature for $50,000 for completion of sewer sys. in suburbs of Oakwood and S. Knoxville. L. Herbert Kidd, Engr.

WATER SUPPLY AND PURIFICATION

Ark., Fayetteville—City will extend and renew water system; daily capy. 500,000 gals. E. M. Ratliff, Engr. J. Fulbright.

Ont, Eastview—City will soon receive bids for water mains; cement or cast iron. $54,000. J. C. S. Wolf, Twn. Clk.

Que., Montreal—Metropolitan Comn. soon to ask bids for laying water mains in Montreal North. $160,000.

B. C, Vancouver—Plans being prepared for water extens. to cost $10,000. Mr. Fellowes, City Engr.

Colo., Longmont—City Council has decided to construct new reservoir to increase water supply here. Engr. Bice has submitted complete drawings for the reservoir. Est. cost $50,000.

Ga., Atlanta—City contemplates increasing water works facilities by installation of 5 pumps with total capy. of 100,000,000 gals. daily. Plans call for 2 centrif. pumps for Hemphill water reservoir and 3 15,000,000 gal. pumps for Chattachoochie sta.; cost about $500,000; also approved purchase of three 36-in. valves; one 13-in. valve, one 48-in. valve, cost $10,000.

Ia., Hull—Plans being prepared for 15,000 lin. ft. 4-in. cast iron pipe and appurts. $20,000. W. B. Buell & Co., 205 Davidson Bldg., Sioux City, Engrs.

La., Cedargrove—City will expend $125,000 for water works, $100,000 for sewers, $62,500 for street impvts. and $12,500 for city hall. E. T. Archer & Co., Engrs., Shreveport, La.

La., Covington—City will construct water works and sewers with proceeds of $130,000 5½ per cent bond issue. Robt. Badon, Mayor. L. A. Penand, Twn. Sec.

La., Ponchatoula—City will construct water works and sewer system; vote Sept. 19th on issuance of $130,000 bonds.

Md., Baltimore—City purchased about 175 acres additional land in Baltimore Co. for exten. of Gunpowder sys.; impvts. include high service reservoir, capy. 20,000,000 gals., etc. Plans under constr. Will ask bids in about one month. Wm. A. Megraw, Water Engr., City Hall.

Mass., Fall River—Water Board will make start on linking dead ends of mains of water system. Supt. Moran directed to list amt. of pipe needed for that purpose. Est. cost of impvt., $400,000. Water pipe also ordered laid in Manchester, Slade, Read and Moore Sts. To strengthen weak point in water sys., Board voted to lay 12-in. main in Ray St.—New Boston Rd. to Florence St.

N. Y., Dundee—City plans constr. of water works, including storage reservoir, about 4 miles from here. $15,000. Engineer not selected.

N. Y., Niagara Falls—Plans to enlarge filtr. plant, $300,000. D. G. Fort, 251 2nd St., City Mgr.

O., Cleveland—Formation of san. dist., to take advantage of Cleveland's offer to furnish water supply and sewage disposal service, undertaken by Rocky River, Bay Village, Dover, No. Olmsted and Fairview. Village solicitors will prepare petitions to be presented to respective councils.

O., E. Youngstown—Mahoning Valley Water Co., 403 Mahoning Bank Bldg., Youngstown, plans new booster sta. to supply additional water to large mills. Est. cost $15,000. T. Evans, Supt. Engr. not announced.

Okla., Vinita—City will construct water system; will pipe water from Grand River at Ketchum, 12 miles distant. $297,000 bonds voted.

Ore., Eugene—Plans announced by C. A. McClain, Supt. Pub. Utilities, for bldg. new reservoir at Hendricks Pk., to supply water for Fairmount Dist. Est. cost bet. $15,000 and $20,000.

S. C., Laurens—$65,000 bonds voted for filtration plant.

S. D., Salem—Will soon take bids for filtr. plant. $15,000. Chenoweth & Rettinghouse, 210 Boyce Greely Bldg., Sioux Falls, Engrs.

Tex, Clarendon—City will improve water works. $75,000 available.

Tex., Denison—City will make water works impvts. D. C. Lipscomb, Engr. $50,000 bonds voted.

Tex., Greeneville—City will improve water system, extend sewer system, improve and extend fire system. $125,000 bonds voted.

Tex., Juarez—City considering installation of water meter system. Clemente Garcia, Supt. of Water Wks.

Tex., Mesquite—City will improve sewer and water system. $60,000 bonds voted.

Tex., Mexia—Three issues of bonds for $175,000 water works, $10,000 incinerator and disposal plant, and $65,000 sewer system, approved by Atty. General's Dept. Also approved City of Lancaster water wks. and san. sewer bonds at $15,000.

Tenn., Bristol—$50,000 bonds voted for impvt. of water sys. L. Q. Gammon, Mayor.

Wis., Tomahawk—Wisc. Valley Impvt. Co., 1st Natl. Bank Bldg., Wausau, will construct rein. conc. and steel reservoir dam, including gravel and earth embankment, by Day Labor, at $100,000.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
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—Conduit Rods
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—Cranes, Traveling
—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
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—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
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—Gauges, Steam
—Gauges, Water
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—Hydrants, Fire
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—Pumps, Boiler Feed
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—Pumps, Turbine
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Tarvia.
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One of the largest kilns, set on end, would be as tall as a 20-story building. A touring car could run through it.

The kilns are steel cylinders lined with fire brick. They rest at a slight angle from the horizontal on heavy rollers, and are driven by steel gears at half a revolution a minute. A medium-sized kiln weighs 275,000 pounds, empty, and has foundations as heavy as for a 10-story building.

Into the upper end of the revolving kilns flow the finely ground materials for cement. There they meet a blast of burning pulverized coal, blown in at high pressure from an 8-inch jet at the opposite end.

Where the materials enter the kiln, the temperature is 1,000 degrees Fahrenheit or more. As they tumble over and over on their 3-hour journey through the kiln in the face of the flame, they rise gradually to a temperature of 2,500 to 3,000 degrees—more heat than is required for almost any other industrial process.

The workman, watching through his peephole in the end of the kiln, must wear smoked glasses. It is like looking at the sun.

And if you speak to him, you must shout close to his ears to be heard above the roar of the flames.

In a big cement plant, there will be a dozen or more of these kilns, roaring and revolving side by side in one great room.

A medium-sized kiln's output is 25 barrels an hour, and in that time 3,500 pounds of coal must be blown into it.

You may have seen the great smoke stacks in rows over a cement plant. There is a stack for every kiln, and four kilns make a medium-sized plant, with 3,000 barrels capacity a day or thereabouts. When you see four of these stacks together, you can know that enough coal or equivalent fuel is being burned in the kilns beneath to supply the electricity for the homes, streets, shops and industries of three ordinary cities of 20,000 inhabitants each.

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